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AGRICULTURE AND THE GROWTH OF THE NIGERIAN ECONOMY:

RESULTS OF POLICY SIMULATION EXPERIMENTS\*

by

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I. Preliminary Considerations.

Structurally, agriculture has been, and is still, by far the most important sector of the Nigerian economy. It employs about 80 percent of the adult working population and earns about 60 percent of the gross domestic product (GDP) [1]. This is largely one reason why the country's economic development has been based primarily on the expansion of peasant agricultural production, especially those commodities meant for export. The First National Development Plan 1962-1968 [2], as well as the regional plans before it, recognized this unique importance of primary production by allocating 13.6 percent of plan expenditure to it while trade and industry got 13.4 percent and education got 10.3 percent. In the Second National Development

\* The empirical results for illustrative uses of the Nigerian Simulation Model that we report in this article were run and analyzed as part of the research undertaken when Dr. S. O. Olayide was a Visiting Professor at the Iowa State University, Ames, Iowa in the Fall of 1971. During this time, Dr. Olayide visited East Lansing three times to make the computer runs and to analyze the results.

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Plan 1970-1974, [3] the biggest single sectoral expenditure allocation is transport with 23.7 percent. This was followed in succession by education, with 13.5 percent, and primary production (here defined to include agriculture, livestock, forestry, and fishery), with 10.5 percent of the total public sector program. The questions that immediately come to mind are: Why is there a reversal of the previous ordering of expenditure allocations? Is the primary sector now sufficiently well developed and modernized to be capable of contributing fully and meaningfully to continuing economic development of the country? How do we assess the structural interdependence and the effects of the current or previous policies on the whole economy? What are the main growth variables that need to be tinkered with in the future and current development process? What policy instruments are most germane to this tinkering with economic variables and/or parameters?

Unfortunately, the two national development plans mentioned above are not based on any models that would permit us to experiment with the likely effects of the various policies required to answer the questions posed above. The plan documents are pen, pencil and paper budgeting of costs and returns based on socio-political ranking considerations. To answer the questions posed above, we need a planning model which will enable us to generate data and possible results of the likely effects of tinkering with the parameters of the economic system.

In this paper, our main objective is to demonstrate the practical application of a system simulation model of the Nigerian economy in answering the specific questions of policy in growth-promoting plans as well as to examine the likely effects of given policy variables on growth. Therefore, Section II will be concerned with a brief discussion of the structure and performance of the economy with respect to given "output" and "income generating/depleting"

variables, and in Section III, we shall present a brief summary of the main components of a system simulation model of the Nigerian economy. Section IV will briefly discuss the relevance and content of a list of policy variables or issues to which we have tried to apply the model, especially with respect to the southern regional economy. The results of the system's performance under the basic simplifying and aggregating assumptions of the model are presented graphically and discussed in Section V. We examine in Section VI the areas for further research and development of the model which will enable it to be made an operational aggregate planning tool. The last section is a summary and conclusion of the paper.

## II. Structure and Performance of Nigerian Economy.

In a decade when Nigeria is faced with problems of rising urban unemployment, falling rural incomes, rising rural-urban drift, soaring food prices, perennial food shortages, etc., there is the need to assess, once again, the structure and performance of the economy in terms of growth and economic development. This assessment will improve our understanding and/or knowledge situation as well as focus our attention on the structural components of the economy and the possible requirements for growth. In addition, it will provide us with the necessary policy variables for stimulating economic development.

The essential "output" variables of growth in the Nigerian economy may be grouped into five sectors if we adopt the National Accounts approach. These are primary production, minerals, manufactures-utilities, crafts and "others". A starting point for this structural review is the GDP "output variables" for the period 1950-1967 presented in Table 1. This table shows that the average annual outputs of the five sectors during the 1958-1967 decade are £779.3, £84.0, £56.3, £23.6, and £362.9 millions, respectively,

Table 1. NIGERIA: Output Variables of Growth, 1950-1967 (GDP in £ million).

	Primary Output <sup>1/</sup> (2)	Minerals (3)	Manufactures and Utilities (4)	Crafts (5)	Others (6)	Total GDP (7)
1950	340.9	5.5	3.3	15.8	146.6	512.1
51	388.1	10.7	3.5	15.9	155.0	573.2
52	385.6	11.4	4.9	16.0	196.6	614.5
53	430.8	11.2	6.4	16.1	200.5	665.0
54	500.0	10.0	7.1	16.2	239.9	774.0
55	536.7	10.2	8.4	16.4	255.8	827.5
56	541.7	8.2	12.2	16.5	292.0	870.6
57	565.2	9.4	13.1	16.7	305.6	910.0
58	630.4	7.1	26.7	16.5	243.6	924.3
59	642.6	8.2	34.0	18.3	279.1	982.2
60	711.9	9.9	40.3	20.9	339.3	1122.3
61	732.6	17.0	44.1	21.7	371.3	1186.7
62	804.8	44.9	60.6	21.3	383.8	1315.4
63	837.5	60.6	60.9	23.2	421.0	1403.2
64	839.0	87.9	62.1	24.8	443.2	1457.0
65	845.9	127.4	72.6	28.3	466.1	1540.3
66	892.2	191.1	73.7	30.1	417.9	1605.0
67	856.5	286.6	87.7	31.2	263.9	1525.9
Mean 1958-1967	779.3	84.0	56.3	23.6	362.9	1306.2
Mean 1950-1967	637.9	51.0	34.5	20.3	301.2	1044.9

<sup>1/</sup> Primary Output is here defined to include agriculture, livestock, fisheries and forestry.

Source: F.O.S., Annual Abstracts of Statistics, Nigeria 1969., Lagos, Nigeria.

whilst the mean annual aggregate output is 1306.2 millions. During the eighteen-year period, 1950-1967, the mean annual sectoral outputs are £637.9, £51.0, £34.5, £20.3, and £301.2 millions, respectively, whilst mean annual aggregate output amounted to £1004.9 millions.

The presentation of the sectoral and aggregate outputs, undertaken above, hides the structural magnitudes of these sectors in relation to aggregate output under economic growth. In Table 2, we present the sectoral outputs as percentages of total output. This presentation, simplistic as

Table 2. NIGERIA: Output Variables of Growth, 1950-1967 (GDP-Percentages of Total).

Year (1)	Primary Output (2)	Minerals (3)	Manu- factures and Utilities (4)	Crafts (5)	Others (6)	Minerals as % of Primary Output (7)	Manu- factures & Utilities as % of Primary Output (8)
1950	66.66	1.1	0.6	3.1	28.9	1.6	1.0
51	67.7	1.9	0.6	2.8	27.0	2.8	0.9
52	62.8	1.9	0.8	2.6	31.9	3.0	1.3
53	64.8	1.7	1.0	2.4	30.1	2.6	1.5
54	64.6	1.4	0.9	2.1	31.0	2.0	1.4
55	64.9	1.2	1.0	2.0	30.9	1.9	1.6
56	62.2	0.9	1.4	1.9	33.6	1.5	2.3
57	62.1	1.0	1.4	1.8	33.7	1.7	2.3
58	68.2	0.8	2.9	1.8	26.3	1.1	4.2
59	65.4	0.8	3.5	1.9	28.4	1.3	5.3
60	63.4	0.9	3.6	1.9	30.2	1.4	5.7
61	61.7	1.4	3.7	1.8	31.4	2.3	6.0
62	61.2	3.4	4.6	1.6	29.2	5.6	7.5
63	59.7	4.3	4.3	1.7	30.0	7.2	7.3
64	57.6	6.0	4.3	1.7	30.4	10.5	7.4
65	54.9	8.3	4.7	1.8	30.3	15.1	8.6
66	55.6	11.9	4.6	1.9	26.0	21.4	8.3
67	56.1	18.8	5.7	2.0	17.4	33.5	10.2
Mean 1958-1967	60.4	5.7	4.2	1.7	28.0	9.9	7.1
Mean 1950-1967	62.2	3.8	2.8	2.0	29.2	6.5	4.6

Source: Computed from data in Table 1.

it is, can be interestingly revealing. The percentage calculations show that primary production fluctuated between 62 and 68 percent of aggregate output from 1950-1963 and then started on a downward trend which reached 56 percent in 1967. Mineral output fluctuated between 0.8 and 2.0 percent of aggregate output from 1950-1961 and then started rising very rapidly with the advent of petroleum in commercial quantities to reach 19 percent of aggregate output in 1967. The output of manufactures-utilities presents us

with a trend picture fluctuating between 0.6 and 1.4 percent of aggregate output up to 1957 and then an upward trend culminating in 5.7 percent of aggregate output in 1967. During the entire eighteen-year period, crafts output fluctuated between 1.5 and 3.0 percent of total output. The "others" sector fluctuated between 26 and 34 percent of total output up to 1966 and then dropped to 17.4 percent in 1967. In general, it is seen that for the decade 1958-1967, mean annual contributions to total output by the five sectors are 60.4, 5.7, 4.2, 1.7, and 28.0 percent, respectively. During the entire eighteen-year period, these mean annual contributions to GDP are 62.2, 3.8, 2.8, 2.0, and 29.2 percent, respectively.

It is, however, instructive to highlight the prominence of agriculture in the output framework of the Nigerian economy. In column (7) of Table 2, we present the ratio of the relationship between mineral output and primary output. The calculations show that between 1950 and 1961, mineral output as a percentage of primary output showed a trend oscillating between 1.0 and 3.0 percent and from 1962 the trend turned steeply upwards to culminate in 34 percent of primary output in 1967. Recent indications show that this steep upward trend will continue. In the case of the output of manufactures-utilities, the calculations in column (8) of Table 2 show that a progressive upward trend with minor oscillations culminating in the highest point of 10.2 percent of primary output in 1967 has been manifest. The data in columns (7) and (8) of Table 2 clearly demonstrate the dangerous and misleading attempts to de-emphasize agricultural development in our current thoughts on planned economic development. The policy is especially dangerous in view of the seriousness of the questions posed in Section I of this paper, since they are now more menacing to the economy than they were in the 1950's. The current de-emphasis may have deleterious effects on economic growth in view of the fact that our primary production is still anything but modern

and efficient and hence cannot perform satisfactorily under rising population, increasing demands for food and fibre of good quality, and increasing pressures on land arising from problems of bush-fallow systems under economic development.

To examine the sectoral rates of growth as possible explanations of de-emphasis and as policy instruments, we present in Table 3 the annual percentage increase or decrease in the output of each of the five sectors during the eighteen-year period. The annual rate of increase of primary output has shown wide swings from a mean annual rate of 9.7 percent during 1950-1955 to 5.9 percent during 1956-60, and 2.8 percent during 1961-67. For the same three subperiods, the mean annual rates of increase in output of minerals in value terms are 16.2, 1.4, and 65.8 percent, respectively. Those for manufactures-utilities are 21.2, 40.4, and 14.5 percent, respectively, while crafts' rates are 0.7, 5.1 and 6.0 percent, respectively. During the decade 1957-58 to 1966-67, the mean annual rates of increase in outputs of the five sectors are 4.4, 47.2, 25.4, 6.6, and 0.2 percent, respectively, while aggregate rate of increase in output is 5.4 percent. Over the entire period under review these rates are 5.7, 32.3, 24.3, 4.2, and 4.8 percent, respectively, while aggregate rate of growth is 6.7 percent.

The phenomenal rates of increase in the output of minerals should not mislead us into believing that it could continue forever since we have to realize that minerals are an exhaustible as well as irreplaceable commodity in the national output space. The mean annual growth rate of output of manufactures-utilities sector at 24.3 percent has led to a parading of this as "the growth" sector of the economy without recalling the fact that its mean annual contribution of 2.8 percent of aggregate output is only 4.6 percent of the mean annual output from primary production during the entire eighteen-year period. This examination of relationships highlights the

Table 3. NIGERIA: Rates of Growth of Output Variables, 1950-1967  
(GDP-Percentages).

Year (1)	Primary Output (2)	Manufactures and				Total GDP (7)
		Minerals (3)	Utilities (4)	Crafts (5)	Others (6)	
1950-51	13.8	94.5	6.1	0.6	5.7	11.9
51-52	- 0.6	6.5	40.0	0.6	26.8	7.2
52-53	11.7	- 1.8	30.6	0.6	2.0	8.2
53-54	16.1	-10.7	10.9	0.6	19.7	16.4
54-55	7.3	- 7.3	18.3	1.2	6.6	6.9
Mean 1950/51-54/55	9.7	16.2	21.2	0.7	12.2	10.1
1955-56	0.9	-19.4	45.2	0.6	14.2	5.2
56-57	4.3	14.6	7.4	1.2	4.7	4.5
57-58	11.5	-24.5	103.8	-1.2	-20.3	1.6
58-59	1.9	15.5	27.3	10.9	14.6	6.3
59-60	10.8	20.7	18.5	14.2	21.6	14.3
Mean 1955/56-59/60	5.9	1.4	40.4	5.1	7.0	6.4
1960-61	2.9	71.7	9.4	3.8	9.4	5.7
61-62	9.9	164.1	55.5	-1.8	3.4	10.8
62-63	4.1	35.0	0.5	8.9	9.7	6.7
63-64	0.2	45.0	2.0	6.9	5.3	3.8
64-65	0.8	44.9	16.9	14.1	5.2	5.7
65-66	5.5	50.0	1.5	6.4	-10.3	4.2
66-67*	-4.0	50.0	19.0	3.7	-36.9	-4.9
Mean 1960/61-66/67	2.8	65.8	14.5	6.0	-2.0	4.6
Mean 1957/58-66/67	4.4	47.2	25.4	6.6	0.2	5.4
Mean 1950/51-66/67	5.7	32.3	24.3	4.2	4.8	6.7

Source: Computed from data in Table 1.

\*The negative growth for this period is due to the Civil War.

necessity for having a model which enables us to assess the structural as well as output effects of using sectoral policy instruments on the whole economy.

An interesting policy-oriented way of measuring the structural performance of the Nigerian economy is to examine the magnitudes and/or growths of income-generating and/or income-depleting variables in the system. [5] In this case, it is always ideal to examine the structure with respect to such

variables as imports and exports (in terms of foreign trade earnings), government revenue, capital formation (private, public and gross), and changes in money supply. These income-related variables have important implications for developmental, compensatory, and regulatory policies in sectoral planning and plan implementation. In Table 4, we present the magnitudes of these

Table 4. NIGERIA: Income Variables in Growth, 1950-1967 (£ millions).

Year (1)	Exports (2)	Imports (3)	Government Revenue (4)	Public Capital Formation (5)	Private Capital Formation (6)	Gross Capital Formation (7)	Money Supply (8)
1950	90.2	61.9	35.0	9.5	27.1	36.6	68.9
51	120.1	84.6	41.2	11.5	30.3	41.8	72.6
52	129.5	113.3	60.1	18.2	35.8	54.0	76.4
53	124.2	108.3	69.8	19.9	43.7	63.6	80.4
54	149.5	114.1	78.2	25.8	45.7	71.5	84.6
Mean 1950-1954	122.7	96.4	56.9	17.0	36.5	53.5	76.6
1955	132.5	136.1	98.7	29.9	55.8	85.7	78.5
56	134.6	152.8	97.1	33.5	67.7	101.2	86.5
57	127.5	152.5	112.8	38.2	74.8	113.0	91.1
58	135.6	166.3	114.4	29.8	91.2	141.0	90.8
59	163.5	178.4	123.2	61.8	86.7	148.5	93.7
Mean 1955-1959	118.7	157.2	109.2	42.6	75.2	117.9	88.1
1960	169.7	215.9	139.0	61.5	101.8	163.3	120.4
61	173.6	222.5	166.9	60.3	128.8	189.1	121.5
62	168.5	203.3	178.9	64.6	137.1	201.7	126.2
63	189.7	207.6	183.9	63.4	113.6	177.0	134.3
Mean 1960-1963	175.4	212.3	167.2	62.5	120.3	182.8	125.6
1964	214.7	253.8	192.4	68.0	127.0	195.0	158.8
65	268.3	275.3	239.2	80.7	144.7	225.4	158.5
66	284.1	256.4	256.6	87.5	145.8	233.3	172.5
67	270.0	223.6	268.9	79.9	130.5	210.4	157.2
Mean 1964-1967	259.3	252.3	239.3	79.0	137.0	216.0	161.8
Mean 1958-1967	203.8	220.3	186.3	67.8	120.7	188.5	133.4
Mean 1950-1967	169.2	173.7	136.5	48.0	88.2	136.2	109.6

Source: Olatunbosun, D., and S.O. Olayide, Commodity Exports and Economic Growth in Nigeria NISER Research Monograph (Mimeo--to be published) 1971.

income related variables to facilitate an examination of the performance of the Nigerian economy during the period 1950-1967.

The data in the table show that during the decade 1958-1967, the average annual values of these variables in millions are £203.8 of exports, £220.3 of imports, £186.3 of government revenue, £67.8 of public capital formation, £120.7 of private formation, and £133.4 of money supply. During the whole period these mean annual values are £169.2, £173.7, £136.5, £48.0, £88.2, £136.2, and £109.6 millions, respectively. These absolute values do not tell the whole story in a revealing way that will enable us to examine the likely effects of new policy instruments.

To enable us to realistically appreciate the real growth patterns or trends, we present in Table 5 the annual percentage increase or decrease in values of the variables. From the table, we see that imports have been growing at a higher rate than exports during the entire period and this performance explains the continuing adverse balance of trade up to 1966-67. Public capital formation has been growing at a higher rate than government revenue, and this is indicative of the utilization of Marketing Boards as fiscal instruments. Also public capital formation has been increasing at a faster rate than private capital formation, a situation indicating ventures as well as the impoverishment of primary producers. Lastly, total money supply during the decade 1958-67 was growing at a mean annual rate of 6.1 percent which is greater than the 5.4 percent mean annual rate for GDP and 4.4 percent rate in primary output during the same period. This situation is indicative of the moderate inflationary tendency in the economy and this tendency has recently been heightened by the after maths of the Civil War.

This bird's-eye view of the structure and performance of the Nigerian economy during 1950-1967 attests the need to provide the policy maker with

Table 5. NIGERIA: Growth Rates of Income Variables, 1950-1967 (Percentages)

Year (1)	Exports (2)	Imports (3)	Government Revenue (4)	Public Capital Formation (5)	Private Capital Formation (6)	Gross Capital Formation (7)	Money Supply (8)
1950-51	12.0	36.7	17.7	21.1	11.8	14.2	5.4
51-52	7.8	33.9	45.9	58.3	18.2	29.2	5.2
52-53	- 4.1	- 4.4	16.1	9.3	22.1	17.8	5.2
53-54	20.4	5.4	12.0	29.6	4.6	12.4	5.2
Mean	11.5	17.9	22.9	29.6	14.2	18.4	5.3
54-55	-11.4	19.3	26.2	15.9	22.1	19.8	- 7.2
55-56	1.6	12.3	- 1.6	12.0	21.3	18.1	10.2
56-57	- 5.3	- 0.2	16.2	14.0	10.5	11.7	5.3
57-58	6.4	9.0	1.4	30.4	21.9	24.8	- 0.3
Mean	- 2.2	10.1	10.6	18.1	18.9	18.6	2.0
58-59	20.6	7.3	7.7	24.1	- 4.9	5.3	3.2
59-60	3.8	21.0	12.8	- 0.5	17.4	10.0	28.5
60-61	2.3	3.1	20.1	- 2.0	26.5	15.8	0.9
61-62	- 2.9	- 8.6	7.2	7.1	6.4	6.7	3.9
Mean	6.0	5.7	12.0	7.2	11.4	9.5	9.2
62-63	12.6	2.1	2.8	- 1.9	-18.1	-12.2	6.4
63-64	13.2	22.3	4.6	7.3	11.8	10.2	18.2
64-65	25.0	8.5	24.3	18.7	13.9	15.6	- 0.2
65-66	5.9	- 7.8	7.3	8.4	0.8	3.5	8.8
66-67	- 5.0	-12.8	4.8	- 8.5	-10.5	- 9.8	- 8.9
Mean	10.3	2.5	8.8	4.8	- 0.4	1.5	4.9
Mean 58-67	8.2	4.4	9.3	8.3	6.5	7.0	6.1
Mean 50-67	6.1	8.7	13.3	14.3	10.3	11.4	5.3

Source: Computed from data in Table 4.

an operational model of the economy in order to enable him to compare and contrast the effects of alternative policies in terms of an array of familiar variables. On the basis of the results of these comparisons and contrasts, he can rank or order his choice of policy instruments. To do this meaningfully, the

aggregate model has to correspond very closely and/or correctly to changes at issue in growth policies. With this vital need in mind--and cognisant of the fact that a simulation model of an economic system is not expected to produce "perfect" absolute quantitative results, which is an impossibility anyway, but rather relative qualitative information--a simulation model of the Nigerian economy has been developed. The essential motivation was to provide an improvement on the traditionally less efficient pen, pencil and paper budgetary planning methods.

### III. The Nigerian Simulation Model.

The simulation model of an economy can be compactly described mathematically by a system of equations such as:

$$\text{EQ.1. } W_{t+1} = F(W_t, a_t, b_t, g_t)$$

$$\text{EQ.2. } X_t = H(W_t, W_t^*)$$

$$\text{EQ.3. } \Pi_t = G(W_t, a_t, b_t, g_t)$$

where:

$W_t$  = a vector (set of variables) defining the state of the simulated system at any given time  $t$

$W_t^*$  = a vector of variables describing the state of the system in the real world

$a_t$  = set of structural parameters involving rates of change of variables, or input-output coefficients of the system

$b_t$  = set of exogenous variables influencing the system's behavior, e.g., world prices, weather, etc.

$g_t$  = set of controllable or policy variables that can be employed to alter the system's performance, e.g., duties, tax policies, investment alternatives, etc.

$X_t$  = set of intermediate output variables measuring the extent to which the model of the system  $W_t$  meaningfully corresponds to reality  $W_t^*$

$\Pi$  = set of output variables that measure the system's simulated attainment of various "improvement levels" such as projects, income, rates of growth of foreign exchange earnings, etc., or levels of retrogression such as unemployment, adverse trade balance, falling real income, food shortages, etc.

The simplified formulation in EQ.1. is a general implicit representation of the difference equation formulation that describes the system's state and its subsequent performance at discrete points in time. The implicit function in EQ.2. illustrates those equations in the model that are used to measure how well the simulated variable  $W_t$  corresponds to the real world data  $W_t^*$ . Implicitly, EQ.3. represents those equations in the system that attempt to indicate how many "improvements" are attained and how many "retrogressions" result.[6]

The simulation model of the Nigerian economy is a very large, aggregated, and essentially much more complex system than the three implicit functions above can attempt to show. It involves over 2,000 equations and well over 10,000 variables. To appreciate this complex system, for the purpose of testing policy instruments, we present in Figure 1 a diagrammatic representation of the national simulation model. This figure depicts the model of the economy as comprising three sub-models which are: (1) the northern agricultural, (2) the southern agricultural, and (3) the national nonagricultural sub-models. [7] On the left-hand side of the figure are the exogenous variables flowing into the system while the performance variables are those flowing out of the system on the right-hand side. Each of the three sub-models has two interacting parts (activity and demography) which are linked together by the flow of income, labor force, and the demands for supplies of goods and services. Interregional trade, which is manifest in the shipments of food between the northern and the southern regions, constitutes the major interaction among the sub-models.

In Figure 2, we present diagrammatically the northern agricultural sub-model in a much more informative setting. This sub-model comprises five main components. The first is the cattle production component, designed to simulate

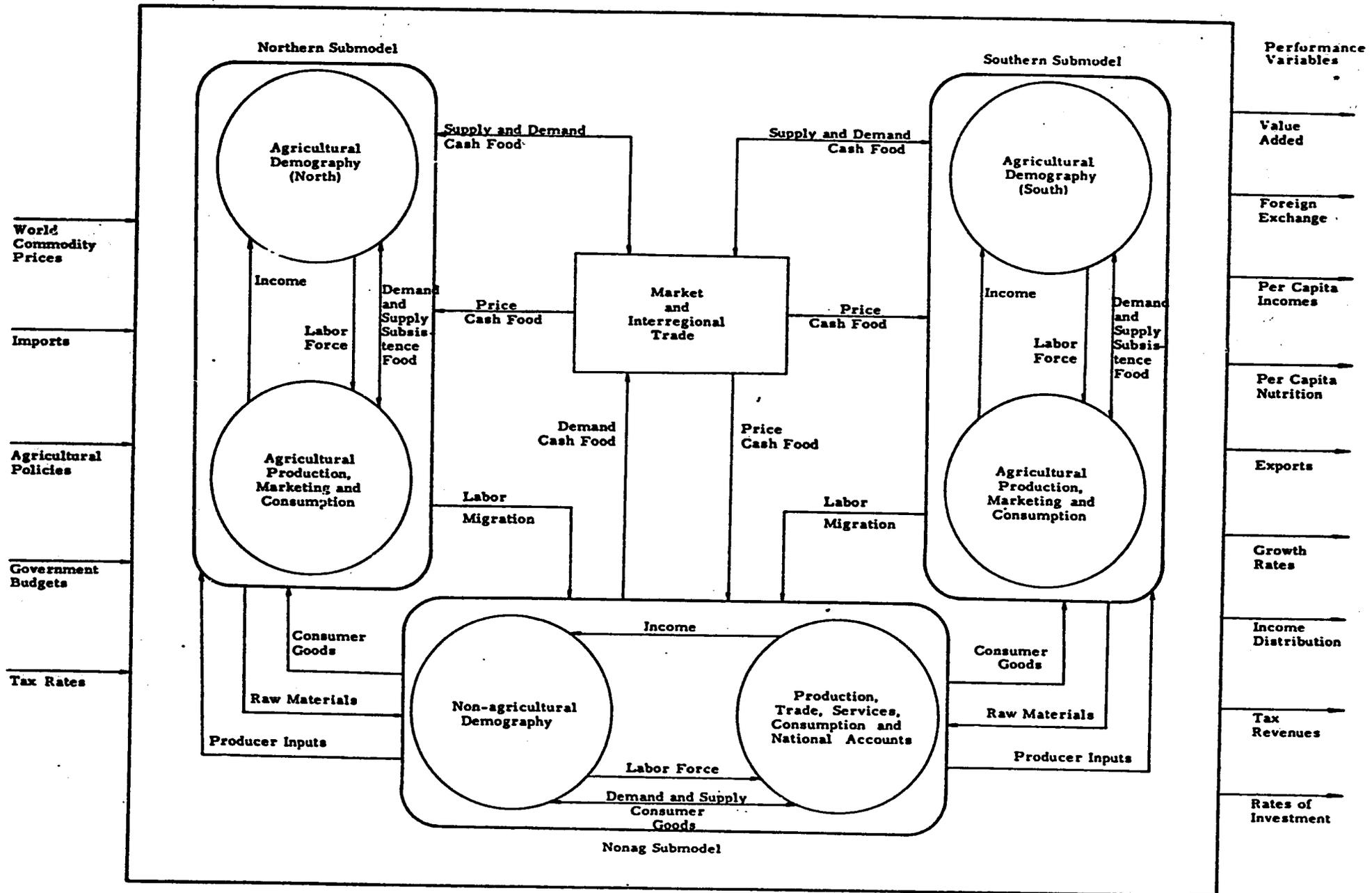


Figure 1  
National Model of Interacting Sub-Models

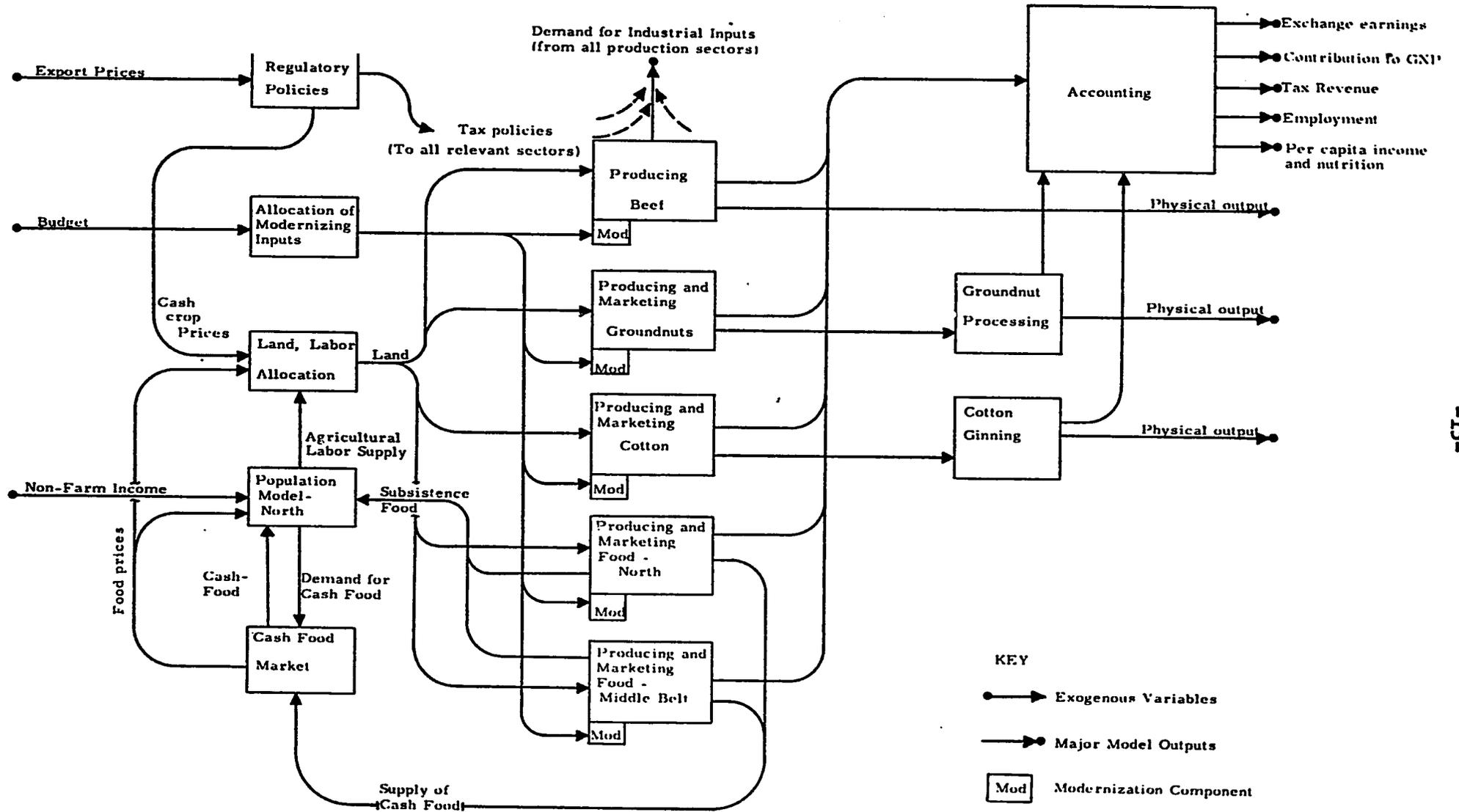


Figure 2.

**Major Sectors and Interactions of the Northern Nigerian Agricultural Model**

meat and milk output from traditional and modernized operations with the use of TDN (total digestible nutrient) inputs from various specified sources. Second, the farm production-distribution component is designed to simulate the production of groundnuts, cotton and composite food from traditional and modernized operations as well as distribute them between domestic uses and exports where appropriate. Third, the land allocation component simulates the use of land in the region among the production of various farm commodities and livestock grazing. Fourth, the modernization component simulates the modernization of agricultural production resulting from extension promotion and from farmer-to-farmer diffusion. Fifth is the consumption-budgetary component which computes sectoral variables such as expenditure on the region's inputs, capital goods, consumer goods, etc. in the agricultural sector, as well as values such as disposable incomes from production and marketing for use in national accounts of the nonagricultural sector.

Figure 3 is a diagrammatic representation of the southern agricultural sub-model. It is shown here to be made up of five basic components. First is the farm production-processing-marketing component which computes the production of cocoa, palm products, rubber, composite food and tobacco from traditional as well as modernized farm operations and, in addition, calculates input demands for labor, capital, chemical and biological resources employed in farm production operations. Second, is the land allocation-modernization component which simulates the allocations of land as between traditional and modernized farm production operations and among the various commodities, based on economic and socio-cultural factors. Third, is the price component which generates world, market, processor and producer prices for farm products in the sub-model. Fourth, the policy component specifies marketing

board and tax policies and allocates funds from a modernization budget to modernization programs and policies in the land allocation-modernization component. Fifth, the accounting component provides outputs for evaluating the performance of the sub-model in addition to allocating inputs to the national accounts section of the nonagricultural sub-model.

In Figure 4, we present a diagrammatic representation of the nonagricultural national sub-model. This sub-model actually serves the purpose of modelling the nonagricultural sectors of the Nigerian economy so as to facilitate their interactions with the agricultural sectors. It also summarizes the accounting variables of both the agricultural and the nonagricultural sectors required to construct a national accounts table, a balance of trade situation, and measures of GDP by branch of activity as well as by category of expenditure.

The market and interregional trade component in Figure 1 links to two regional agricultural sub-models. This component takes regional cash food demands and supplies from the demographic and agricultural production components, respectively, and computer regional market prices of food based on excess demand. Interregional shipments of food then occur as a function of price differences between the regions and transport costs. Finally, the demographic component of the model simulates the growth of the Nigerian population and provides labor and food demands for the agricultural and nonagricultural sectors.

From this overview, we can fully appreciate the complex structure of the system and its possible uses in charting the effects of policy instruments,  $g_t$ , on the economy. Such simulation experiments enable us to compare and rank the effects of alternative developmental, compensatory, and regulatory policies during the plan development, plan implementation and plan revision processes.

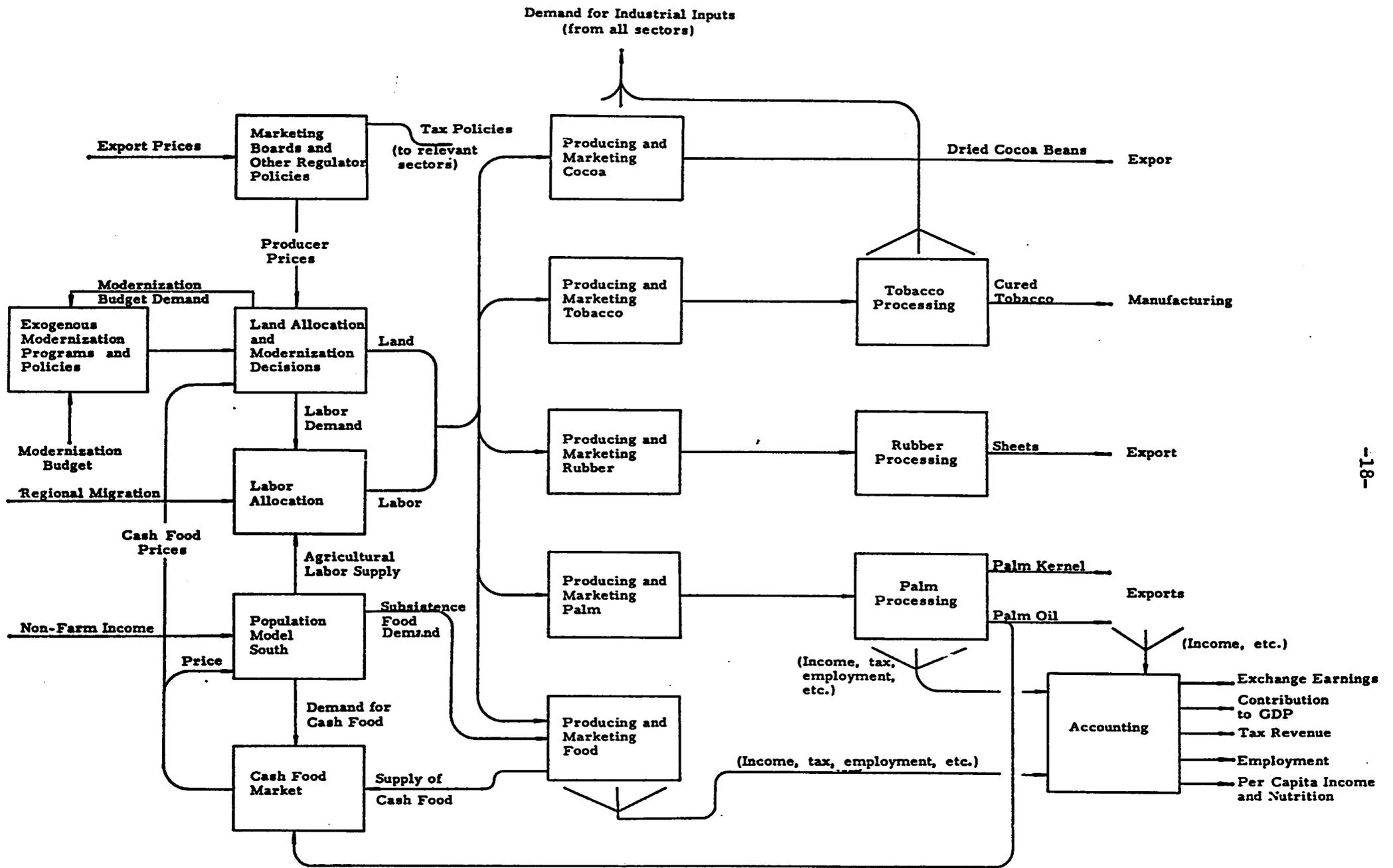
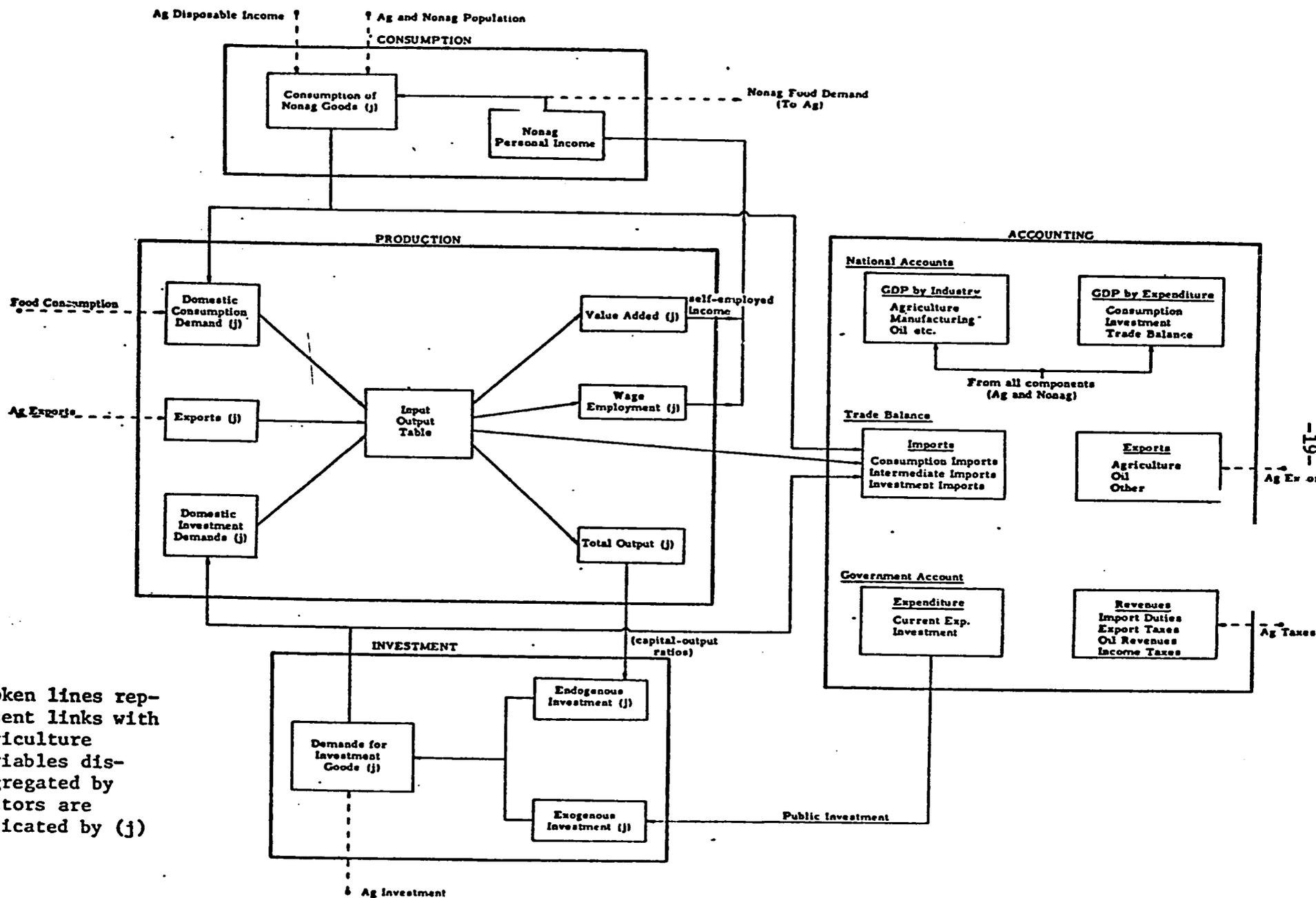


Figure 3

Major Sectors and Interactions of the Southern Nigerian Agricultural Model



- Notes:
1. broken lines represent links with agriculture
  2. variables disaggregated by sectors are indicated by (j)

Figure 4. Model of the nonagricultural economy and the national accounts.

In addition, a model of this form provides policy makers with the likely outcomes of their policies based on a working knowledge of the economy and its interacting relationships. It will also permit a clear specification and determination of the important instrumental policy variables as well as the directions of causation under economic growth.

#### IV. Policy Situations Considered.

The greatest tasks faced in Nigeria's agricultural sector are to modernize the production of cash/export crops as well as the production of arable food crops and fibre. [8] We report here the results of simulation experiments on three forms of policies which can be used in economic planning and plan implementation to stimulate modernized and increased farm production. The first is a regulatory policy which may either cut off CMB surplus accumulation and export duties/taxes or phase them out over some period of time. The second is a developmental campaign and support for new planting and replanting in export crops production, as well as an expanded modernization program for food crops. The third assumes an exogenous policy to stimulate the new planting and replanting of perennial export crops in a specified period of time--no assumption is made as to how this would be accomplished nor to what it would cost.

In Table 6, we present a list of the policy instruments that were run on the Nigerian simulation model to assess their likely effects on the economy. The results were projected to 1995. Questions answered include the likely consequences that the policies will have on production levels, agricultural income, foreign exchange earnings, GDP, increased tax revenues for the public sector, increased demands upon the agricultural sector from the non-agricultural population, and other relevant economic performance criteria.

Table 6. NIGERIA: Policy Instruments in Simulation Runs.

Run No.	Set No.	Policy Instrument of Interest
1.	1, 3, 4, 5	The structure under initial conditions --base run.
2.	1	Cut off marketing board surpluses and export taxes in 1970.
3.	1	Phase out marketing board and export taxes from 1970-1980.
4.	1, 2, 5	Plant new cocoa, replant cocoa, replant palm in palm sector, replant rubber, replant palm in rubber sector.
5.	1	Active production campaign for perennials with marketing board surpluses and export taxes cut off.
6.	1	Active perennials production campaign with CMB surplus and export taxes phased out 1970-1980.
7.	2	Perennial production campaign with a doubling of budget for replanting cocoa.
8.	2	Perennial production campaign with a doubling of budget for replanting palm in the palm sector.
9.	2	Perennial production campaign with doubled budget for replanting rubber.
10.	2	Perennial production campaign with doubled budget for replanting palm in the rubber sector.
11.	2	Perennial production campaign with doubled budget for new cocoa plantings.
12.	5	Active modernization of food production in the perennials sectors.
13.	5	Active modernization of food production in arable crops sectors.
14.	3	Complete cocoa replanting over a 7-year period (quick exogenous stimulus).
15.	3, 4	Complete cocoa replanting over a 15-year period (moderate exogenous stimulus).
16.	3	Complete cocoa replanting over a 25-year period (slow exogenous stimulus).
17.	4	Complete palm replanting in the palm sector with moderate exogenous stimulation over a 15-year period.
18.	4	Complete palm replanting in the rubber sector with moderate exogenous stimulation over a 15-year period.
19.	4	Complete rubber replanting with moderate exogenous stimulation over a 15-year period.

V. Results of Systems Performance.

As shown in Table 6, the first run is, essentially, the base run which presents a status quo agricultural policy situation with little or no change from recent agricultural policies. The current marketing board policies with respect to cocoa and palm products of approximately 25 to 30 percent of revenues as "off-take" over and above their operating expenses are retained. No modernization programs were launched. This is to provide a basis for comparison with the results of the introduction of the various policy instruments in runs 2-19.

The 19 runs are grouped into five rather independent sets (Table G, column 2) for purposes of analysis and graphical presentation. The first set, runs 1-6, examines the relative consequences of various combinations of tax and production campaign policies. The second set, runs 4 and 7-11, look at the relative marginal returns to each of the five perennial production campaigns considered in run 4. Runs 1 and 14-16, the third set of runs, speculate on the likely consequences of various rates of replanting cocoa, with no regard given to how this might be accomplished. The fourth set--runs 1, 15 and 17-19--compares the results of replanting the various perennial commodities over a period of 15 years, again with no regard to how. The final set of runs--runs 1, 4, 12 and 13--are concerned with the modernization of food production in the south in comparison to perennial modernization.

The results of the simulation runs using these policy instruments should be interpreted very cautiously. The note of caution results from the preliminary nature of many of the quantified relationships in the model. This caution does not detract, however, from the usefulness of these results and/or estimates in indicating, in an approximate fashion, the likely qualitative performance of the Nigerian economy under the policy situations studied,

ceteris paribus; as noted earlier, precise quantitative projections are not necessary.

We exercise considerable judgment and selectivity in presenting the results of the various simulation runs. It is much more instructive to present the results in graphical form as a means of usefully and succinctly replacing a lot of dry statistics that would have resulted from the tabulation of the mountain of data generated. Although the graphical form of presentation may not give precise values of output variables, it is certainly the most useful in this connection since simulation efforts should be directed to producing approximate and relative results capable of helping to improve on other planning methods, rather than to obtaining "perfect" and absolute projections. [10]

In Table 7, we present a summary of the selected output results obtained and graphed on the 19 runs, grouped into the five sets discussed above. The output results generated for the southern region are total value added in agriculture, value of exports, value of palm oil exports, revenue accruing to the marketing boards, total labor available in the country as well as the amount of labor demanded in the region, per capita disposable income, price of composite food, level of nonfarm income, and per capita nonfarm food consumption. These are the few selected from well over 75 performance results that the model generates.

An analysis of the 19 policy runs of the simulation model would be in terms of the five sets. To explain behavior simulated under different policy conditions (e.g., as observed in the graphs, Figures 5-40) requires an understanding of, and familiarity with, the simulation model--i.e., its structural relationships and its simplifying and aggregating assumptions.

Table 7. NIGERIA: Summary of System's Perform

Set No.	Figure	Variable Code	Variable Results Graphed	
S1.	5.	TVAS	Total value added in south.	
	6.	VALEXP(2)	Value of southern exports.	
	7.	FXPO	Value of palm oil exports.	
	8.	TMBREV(2)	Marketing board revenue in south.	
	9.	TLABD, AGMU(1,2)	Total labor available and demanded.	
	10.	PCDINA	Per capita agricultural disposable income in south.	
	11.	PRFD(2)	Price of composite food in south.	
	12.	YNFS	Nonagricultural income in south.	
	13.	PCFNAG(2)	Per capita nonagricultural food consumption.	
	S2.	14.	TVAS	Total agricultural value added in south.
		15.	VALEXP(2)	Value of exports in south.
		16.	TMBREV(2)	Total CMB revenue in south.
		17.	TLABD, AGMU(1,2)	Labor available and demanded.
18.		PCDINA	Per capita agricultural disposable income in south.	
S3.		19.	TVAS	Agricultural value added in south.
	20.	VALEXP(2)	Value of southern exports.	
	21.	TMBREV(2)	CMB total revenue in the south.	
	22.	TLABD, AGMU(1,2)	Labor available and demanded.	
	23.	PCDINA	Per capita agricultural disposable income in south.	
	24.	PRFD(2)	Price of composite food in the south.	
	25.	PCFNAG(2)	Per capita nonagricultural food consumption in south.	
S4.	26.	TVAS	Agricultural value added in south.	
	27.	VALEXP(2)	Value of south's agricultural exports.	
	28.	FXPO	Value of palm oil exports.	
	29.	TMBREV(2)	Marketing board revenue in south.	
	30.	TLABD, AGMU(2)	Labor available and demanded in south.	
	31.	PCDINA	Per capita agricultural disposable income in south.	
	32.	PRFD(2)	Price of composite food in south.	
	33.	PCFNAG(2)	Per capita nonfarm food consumption in south.	
S5.	34.	TVAS	Agricultural value added in south.	
	35.	VALEXP(2)	Value of south's agricultural exports.	
	36.	TLABD, AGMU(1,2)	Labor available and demanded.	
	37.	PCDINA	Per capita disposable income in south.	
	38.	PRFD(2)	Price of composite food in south.	
	39.	PCFNAG(2)	Per capita nonagricultural food consumption in south.	
	40.	SUPCFS, SFNS	Supply of food in and shipment of food to south.	

Space here does not permit a complete analysis of all the results appearing in Figures 5-40; however, as an illustration, the results of sets 51 and 52 (runs 1-6 and Figures 5-13; runs 4, 7-11 and Figures 14-18) will be analyzed briefly.

The six runs of set 51 compare the likely consequences of combinations of policies to reduce marketing board surpluses and export taxes and to promote the modernization of perennial production (Table 6). The economic performance criteria plotted in Figures 5-13 are given in Table 7.

The most obvious observation that can be made is that the compounded results of the combinations of production campaigns and higher producer prices (runs 5 and 6) are more than the sum of the results of these policies run separately (runs 2 and 3 and run 4). This is most noticeable in value added (Figure 5), exports (Figure 6) and disposable income (Figure 10). In runs 5 and 6, not only does production increase as a result of modernization but also in response to higher prices. The higher prices also result in a faster rate of modernization.

One general conclusion that might be drawn from this is that price policies produce primarily short-run effects in general. Long term growth would require policies of technological change in agricultural production, preferably in combination with prices favorable to producers.

The six runs of set 52 (Table 6) compare the marginal returns to increases in each of the production campaign budgets. [7, Chapter 4] The five campaigns have equal budgets in run 4; each budget is doubled in turn in runs 7-11. The economic performance criteria plotted in Figures 14-18 include, respectively, agricultural value added, exports, marketing board net revenues, employment and percapita disposable income (Table 7).

In almost all cases, cocoa new planting shows the greatest marginal returns, followed by palm, cocoa and rubber replanting, in that order. This can be explained by faster farmer responses to promotion efforts and faster diffusion rates for new planting than for replanting, which in turn are due to a greater relative profitability of modern perennial land over bush land (new planting) than over traditional perennial land (replanting). [7, Chapter 5]

Within the replanting programs, palm replanting (runs 8 and 10) exhibits greater marginal returns than either cocoa or rubber replanting (runs 7 and 9, respectively) because of the much greater land area in palm production. In particular, in 1970, at the beginning of the policy projection period, the model has 1.81, 4.47 and .831 million acres in cocoa, palm and rubber production, respectively, in southern Nigeria.

Very legitimate questions can be raised concerning the simulated time paths of agricultural employment (Figures 9, 17, 22, 30 and 36) and nonagricultural food consumption (Figures 13, 25, 33 and 39). We give a brief explanation of this behavior below both to provide some insight into how the model works and to emphasize the limited and preliminary nature of the current model.

First, the model considers only the annual supply and demand for labor in terms of man equivalents. Thus, the time paths for labor demand and supply shown in the figures suggest a substantial underutilization of human resources over the course of a year. However, seasonal peaks and valleys--and thus possible seasonal labor constraints--cannot be generated by the current model. A major model revision is necessary to enable the handling of labor constraint problems.

One might conclude, on the basis of the plotted time paths of per capita nonagricultural food consumption (e.g., Figure 13) that urban Nigeria is headed for a dark future. However, a closer look at the model's

assumptions would cast doubt on that conclusion. First, the only food market fully modelled is that for staples, primarily roots and tubers and maize. (Palm oil and beef are treated differently.) Other grains, non-staples (e.g., fruits and vegetables) and imported foods are not considered at all by the model. Secondly, calories are the only nutritional criterion the model looks at. Proteins, vitamins, etc. are ignored. In short, the current model was not designed to answer specific nutritional questions. A fair amount of revision and expansion would be necessary to enable it to do so.

#### VI. Needed Further Work.

The simulation model of the Nigerian economy, comprehensive and complex as it now stands, needs to be expanded and restructured in order to make it operational. Certain theoretical constructs such as investment and disinvestment, inflation and deficit financing, devaluation or revaluation of the currency, occupational versus income taxes, have to be explicitly introduced into the model. Structurally, the ecological regions within the southern and northern sub-models have to be re-defined, based on a comprehensive agricultural census. The employment component of the model needs substantial reworking and expansion to include both labor constraints and rural-urban migration.

It is known in computer simulation that we can get around data problems by running sensitivity tests and then trying to obtain fairly accurate data only for parameters which are so sensitive. In addition, the data problem can be minimized by focusing attention on relative and qualitative results rather than on absolute and quantitative projections. The latter approach may be of more use to policy makers and planners in any case. In summary, we might say that system simulation, as an approach, is able to make better use of the available data than other approaches and techniques, which have been used to make projections, are able to do.

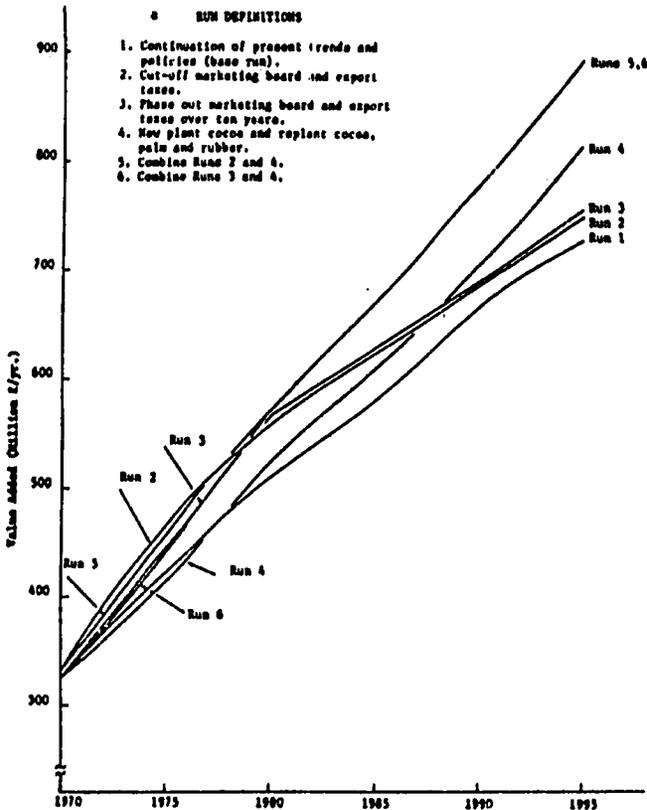


Fig. 5 Total value added in agriculture in the South, 1970-1995, under various policy conditions.

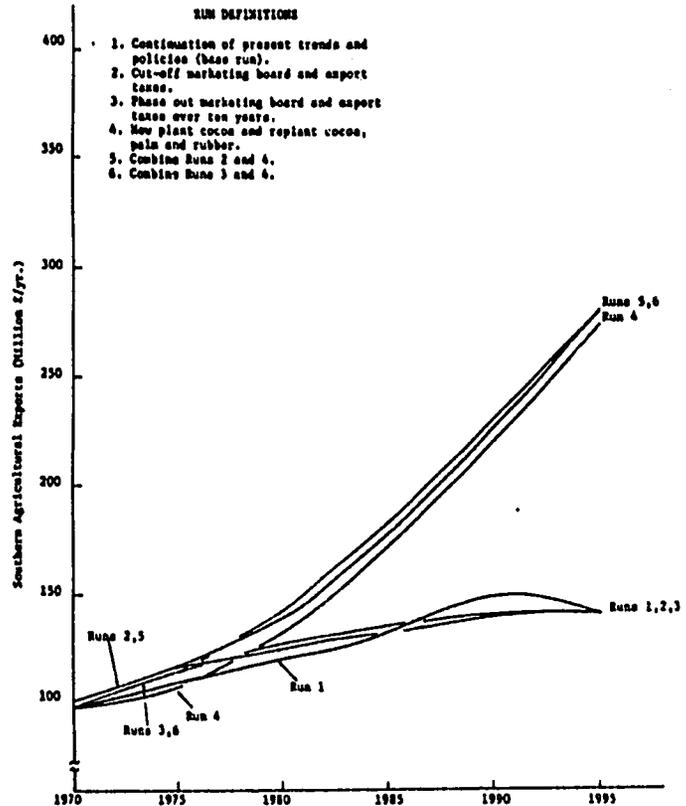


Fig. 6 Foreign exchange from southern agricultural exports, 1970-1995, under various policy conditions.

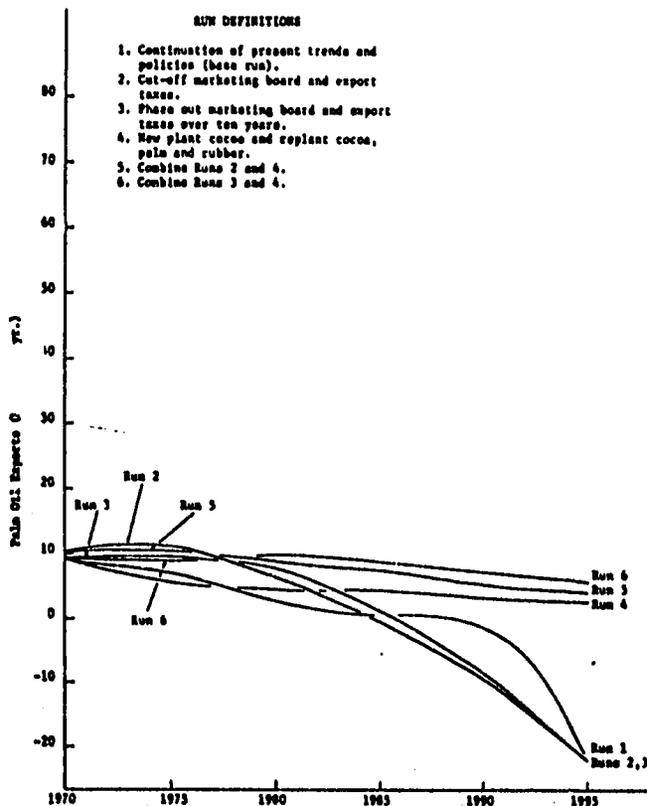


Fig. 7 Foreign exchange from palm oil exports, 1970-1995, under various policy conditions.

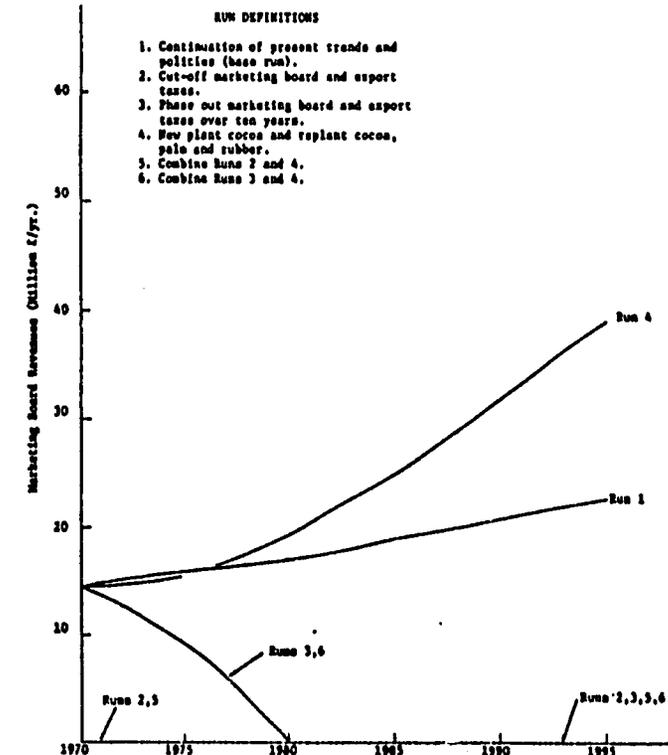


Fig. 8 Total marketing board net revenues from southern commodities, 1970-1995, under various policy conditions.

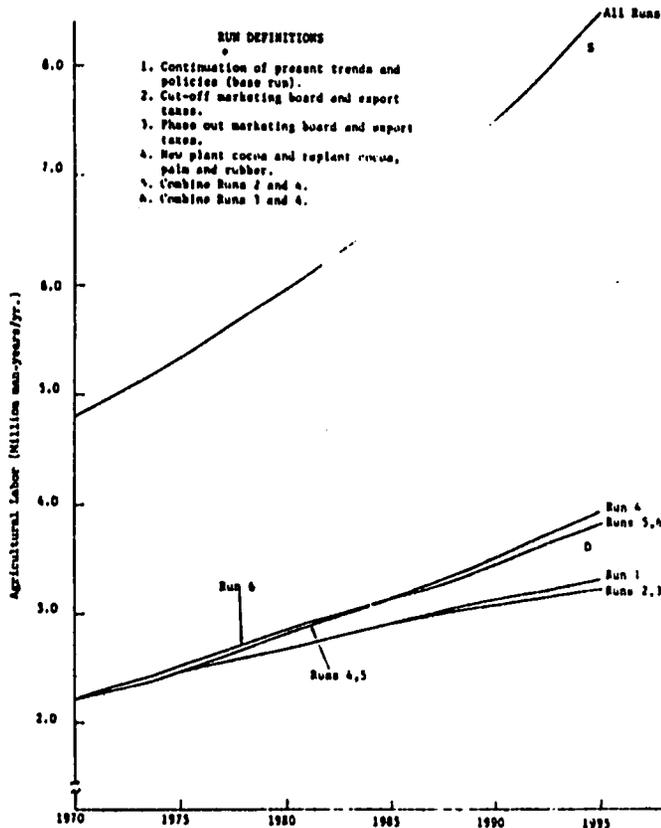


Fig. 9 Southern agricultural labor supply (S) and demand (D) in man-equivalents, 1970-1995, under various policy conditions.

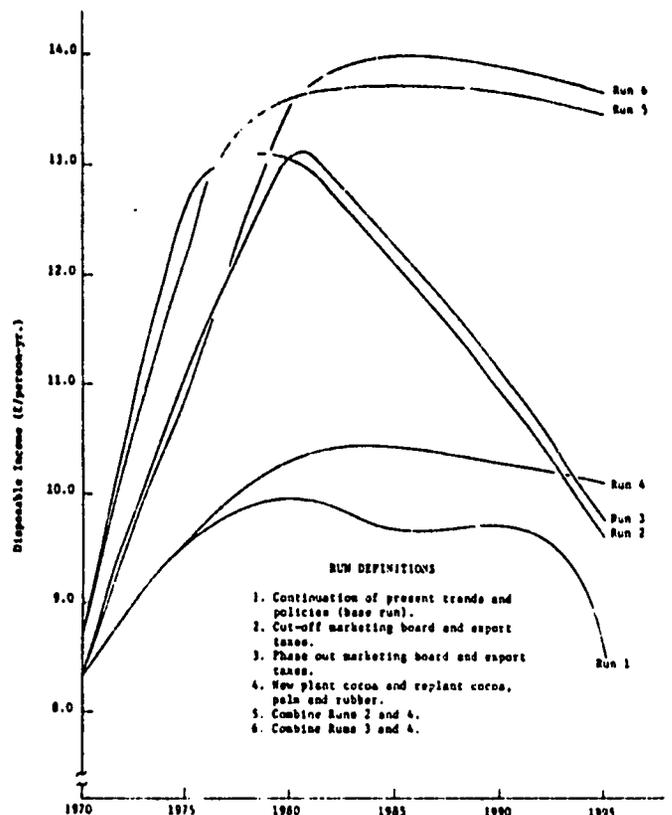


Fig. 10 Disposable income per capita in the South, 1970-1995, under various policy conditions.

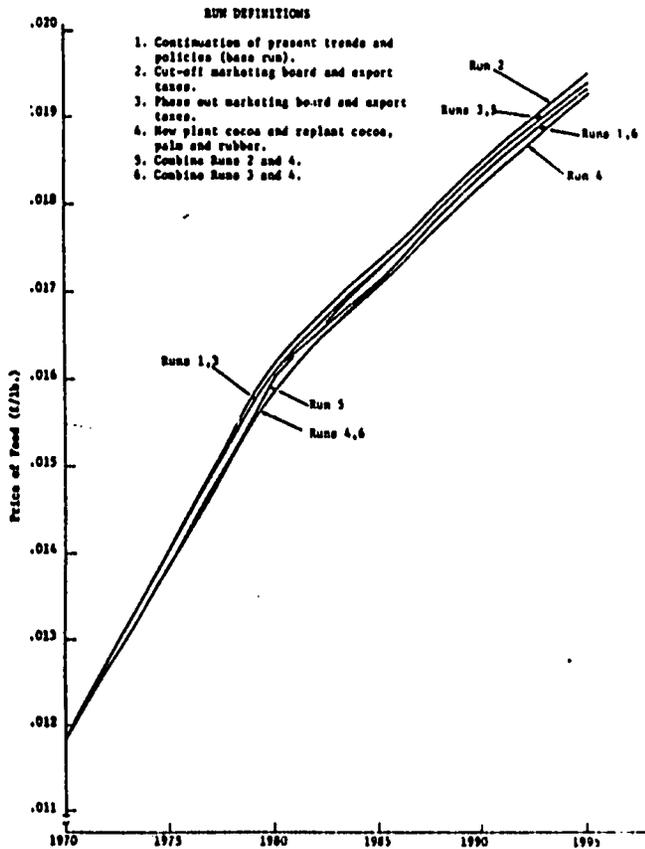


Fig. 11 Market price of food in the South, 1970-1995, under various policy conditions.

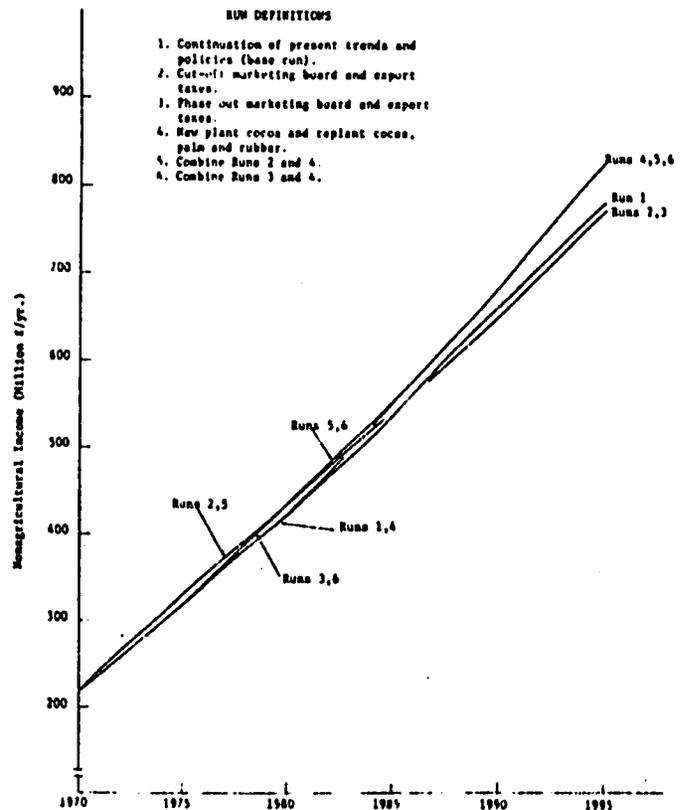


Fig. 12 Nonagricultural income in the South, 1970-1995, under various policy conditions.

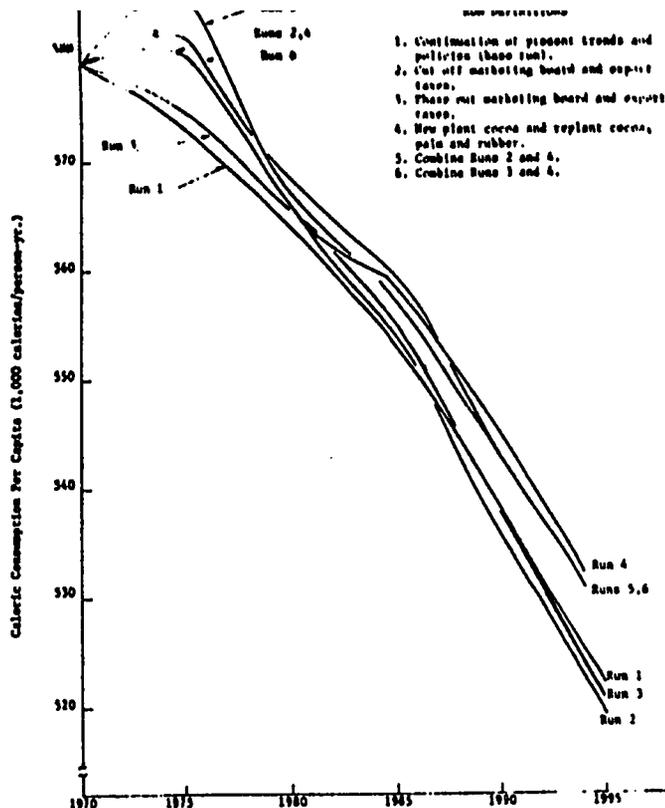


Fig. 13 Caloric consumption (of staples) per capita of the southern nonagricultural population, 1970-1995, under various policy conditions.

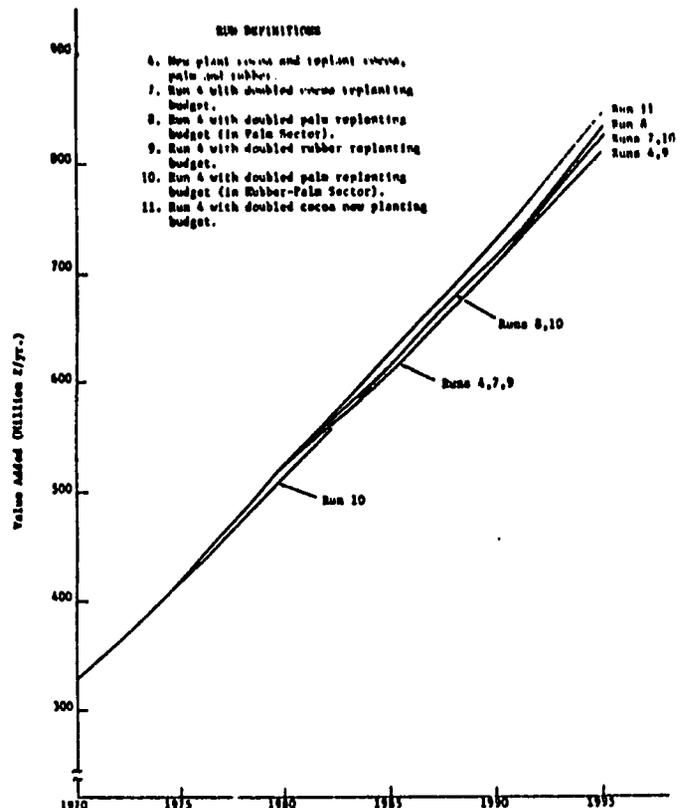


Fig. 14 Total value added in agriculture in the South, 1970-1995, under various policy conditions.

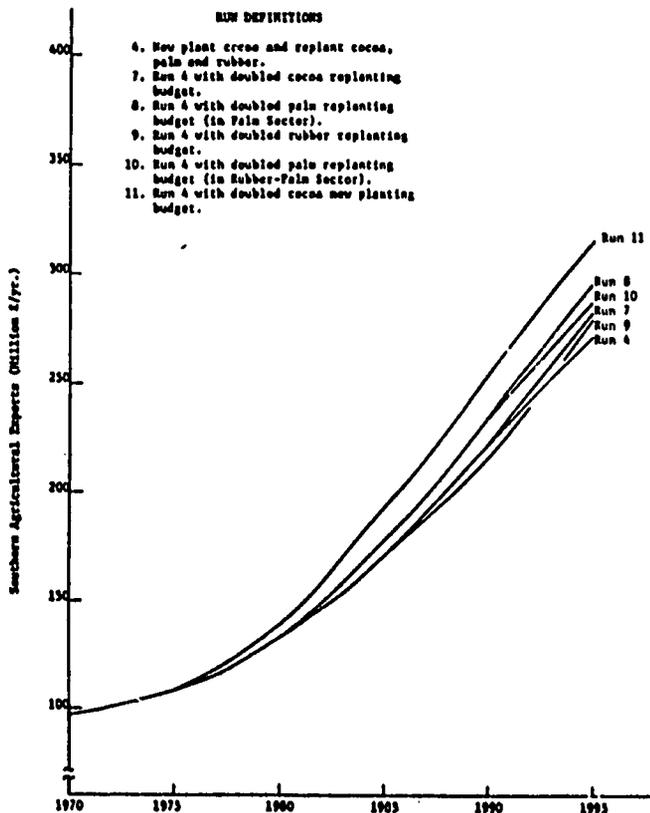


Fig. 15 Foreign exchange from southern agricultural exports, 1970-1995, under various policy conditions.

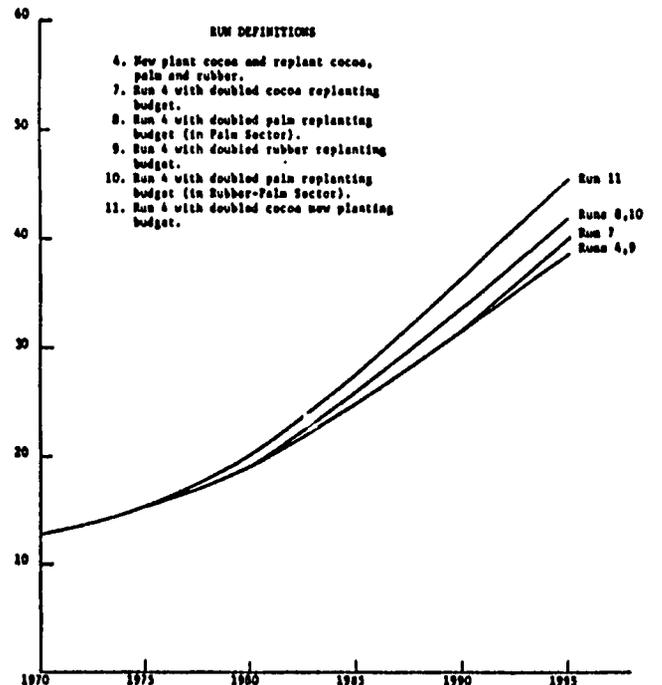


Fig. 16 Total marketing board net revenue from southern commodities, 1970-1995, under various policy conditions.

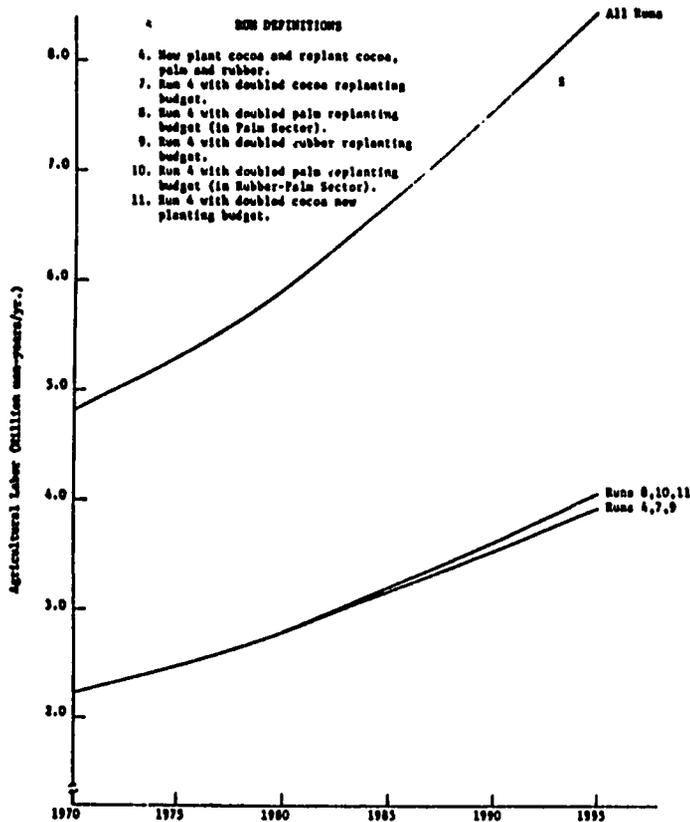


Fig. 17 Southern agricultural labor supply (S) and demand (D) in man-equivalents, 1970-1995, under various policy conditions.

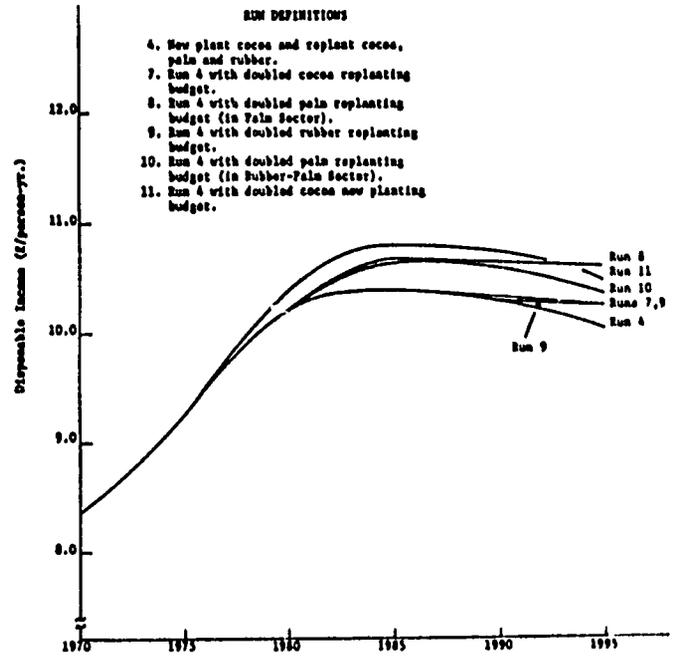


Fig. 18 Disposable income per capita in the South, 1970-1995, under various policy conditions.

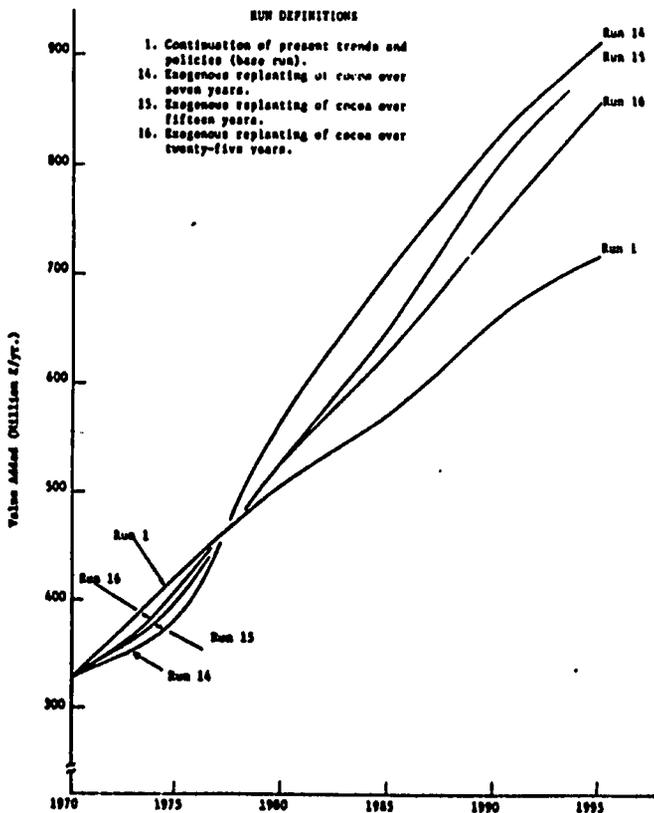


Fig. 19 Total value added in agriculture in the South, 1970-1995, under various policy conditions.

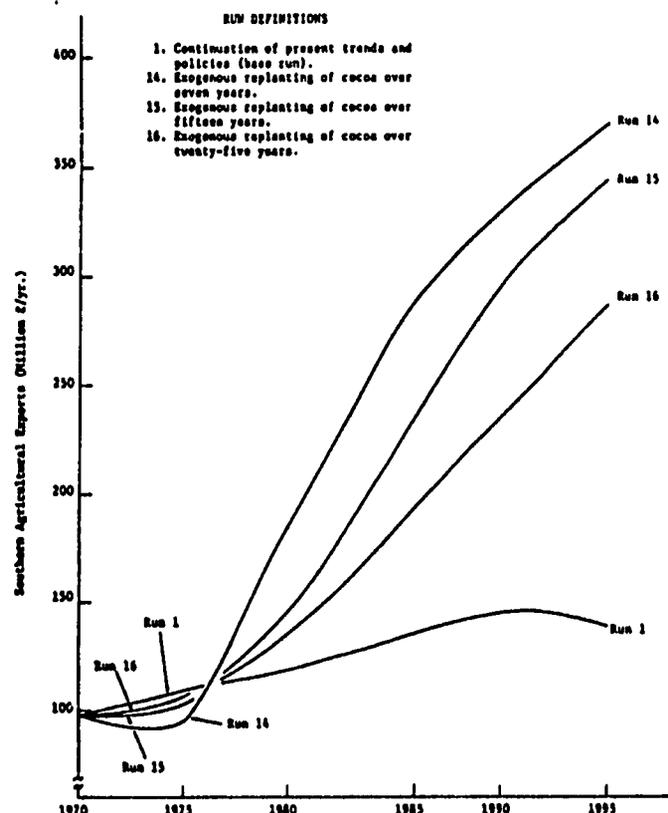


Fig. 20 Foreign exchange from southern agricultural exports, 1970-1995, under various policy conditions.

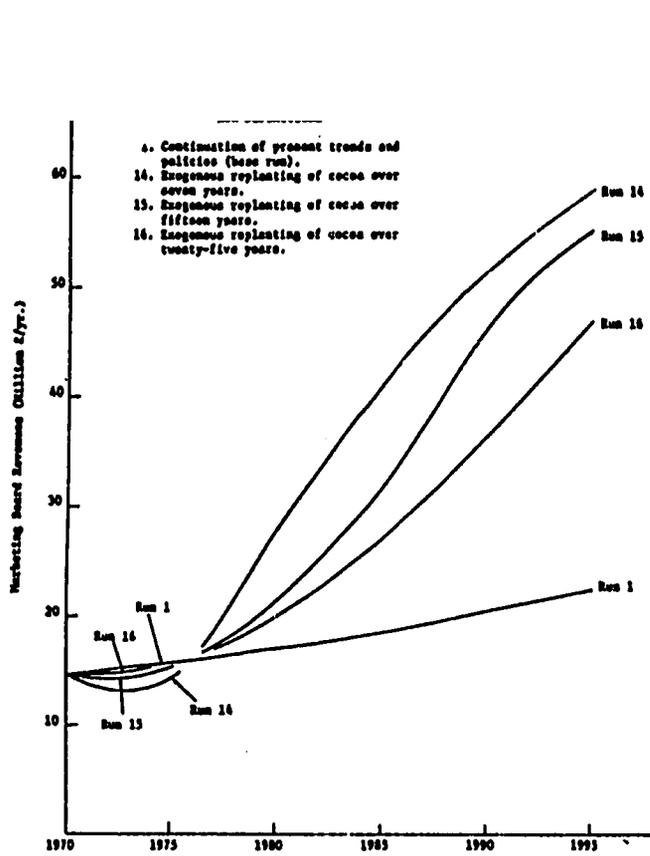


Fig. 21 Total marketing board net revenues from southern commodities, 1970-1995, under various policy conditions.

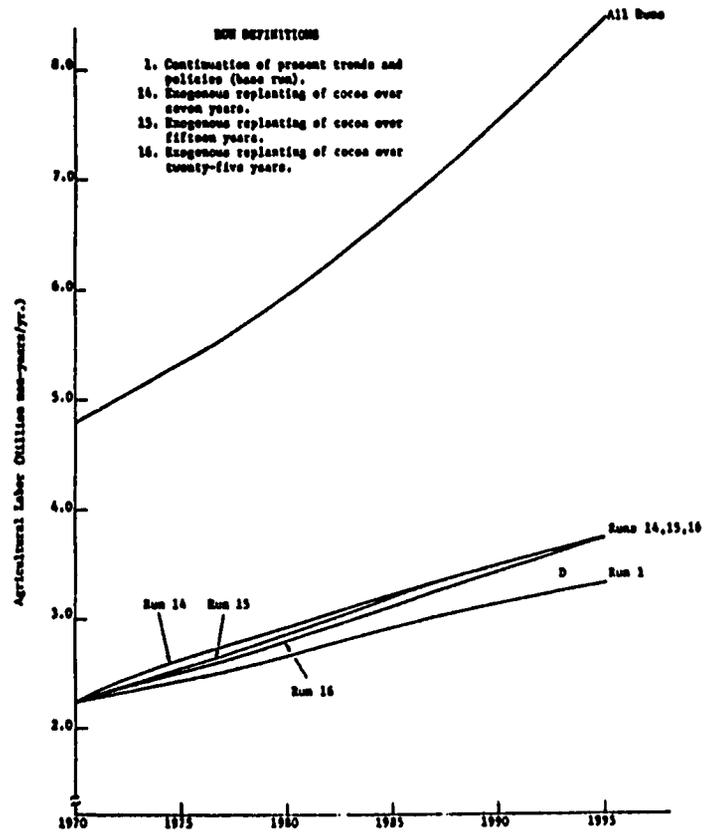


Fig. 22 Southern agricultural labor supply (S) and demand (D) in man-years, 1970-1995, under various policy conditions.

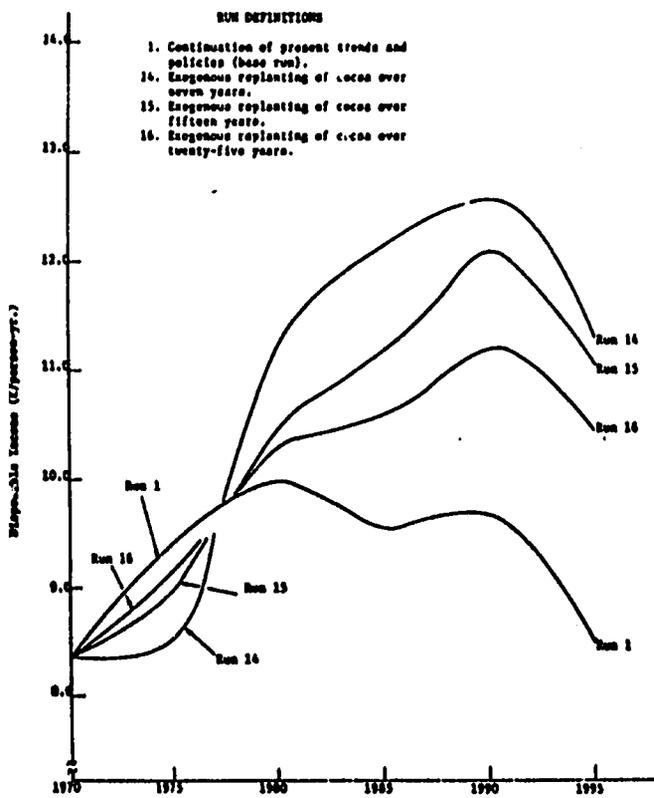


Fig. 23 Disposable income per capita in the South, 1970-1995, under various policy conditions.

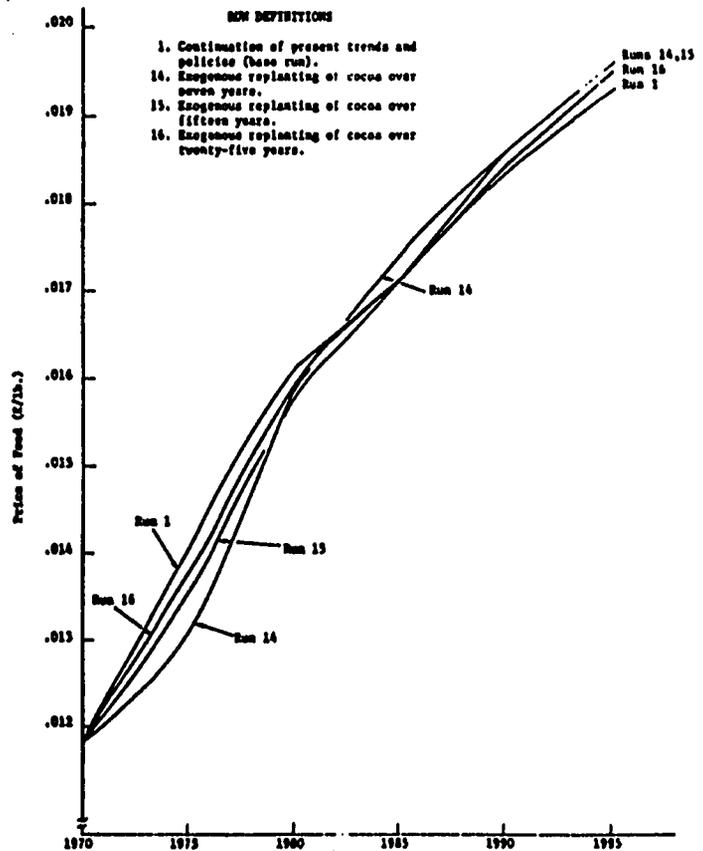


Fig. 24 Market price of food in the South, 1970-1995, under various policy conditions.

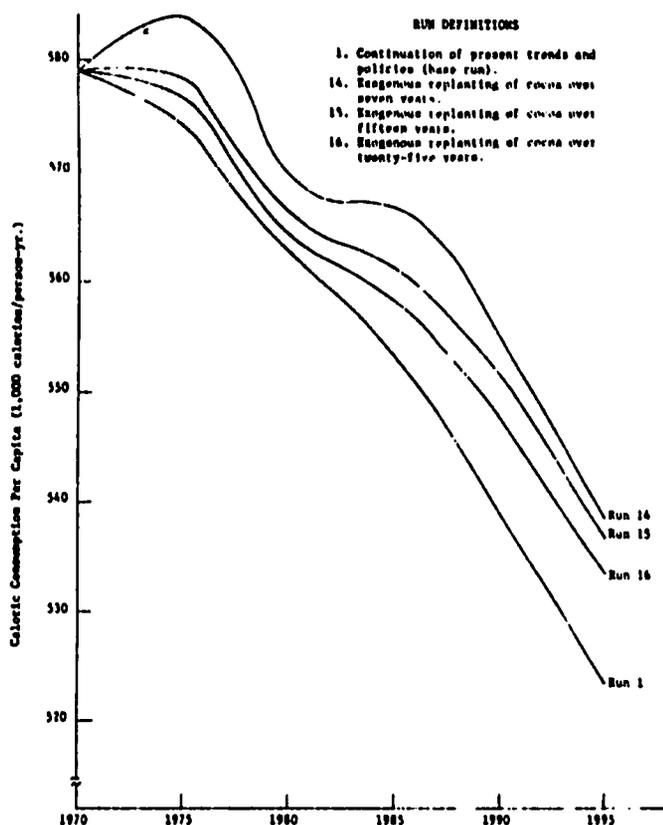


Fig. 25 Caloric consumption (of staples) per capita of the southern nonagricultural population, 1970-1995, under various policy conditions.

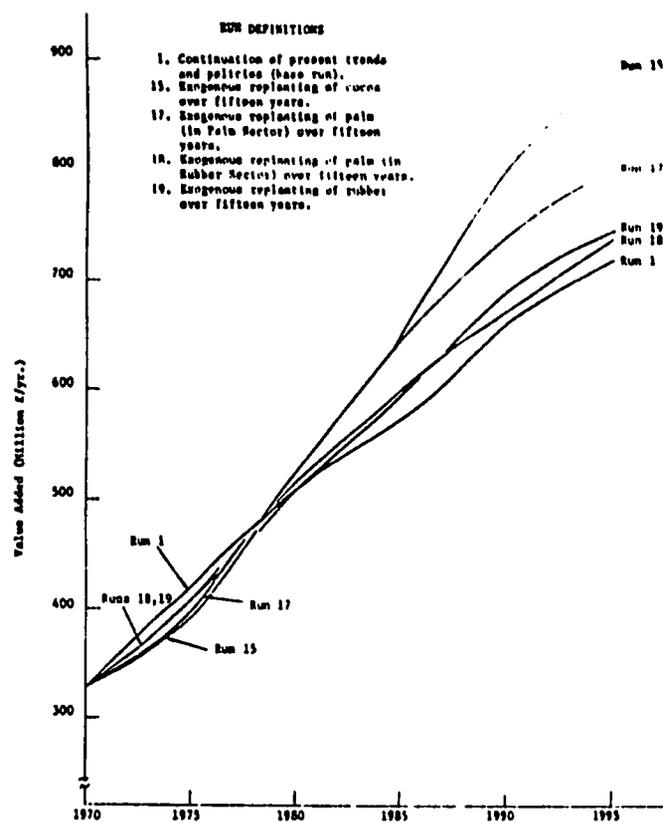


Fig. 26 Total value added in agriculture in the South, 1970-1995, under various policy conditions.

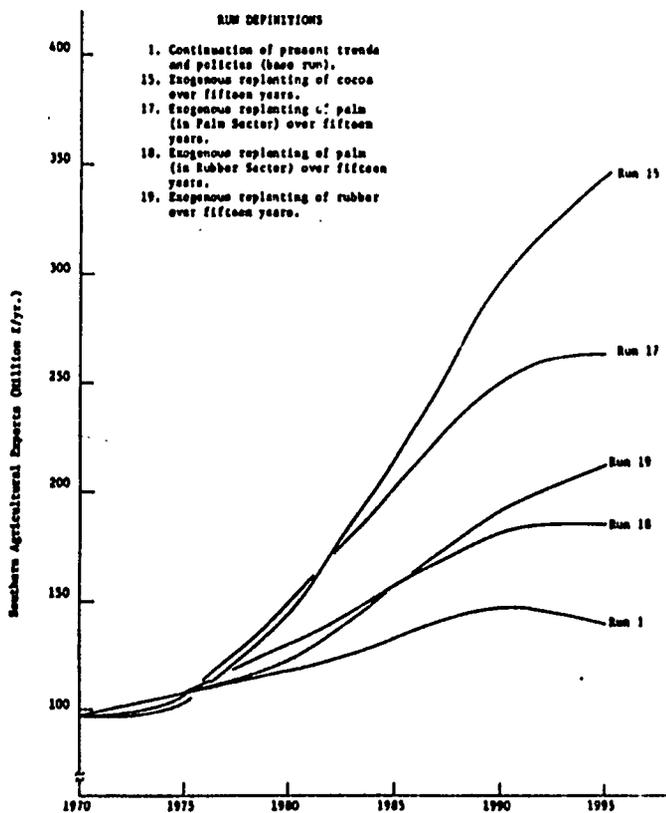


Fig. 27 Foreign exchange from southern agricultural exports, 1970-1995, under various policy conditions.

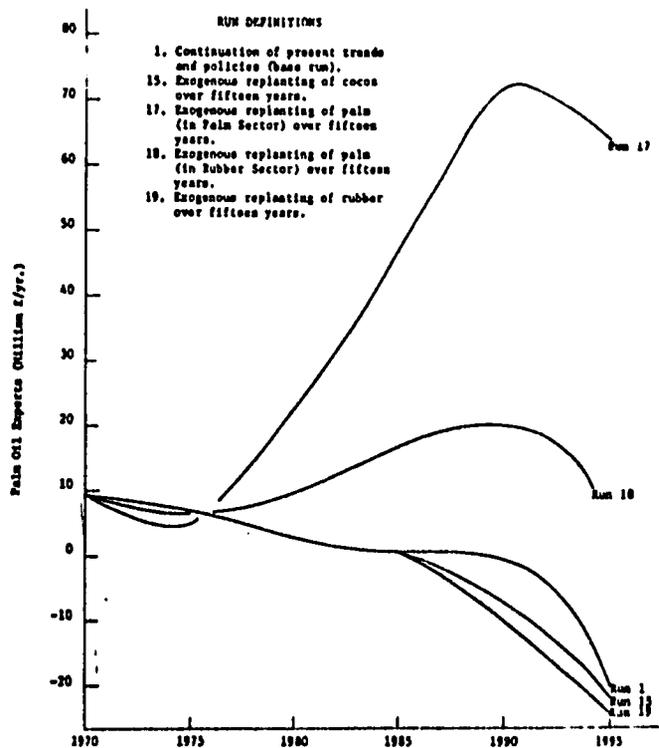
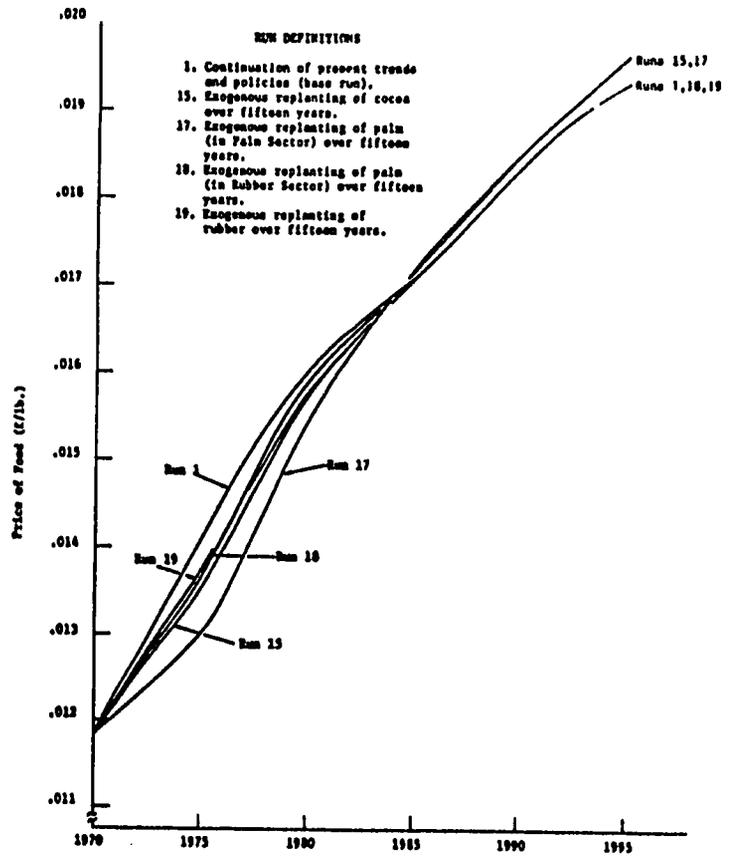
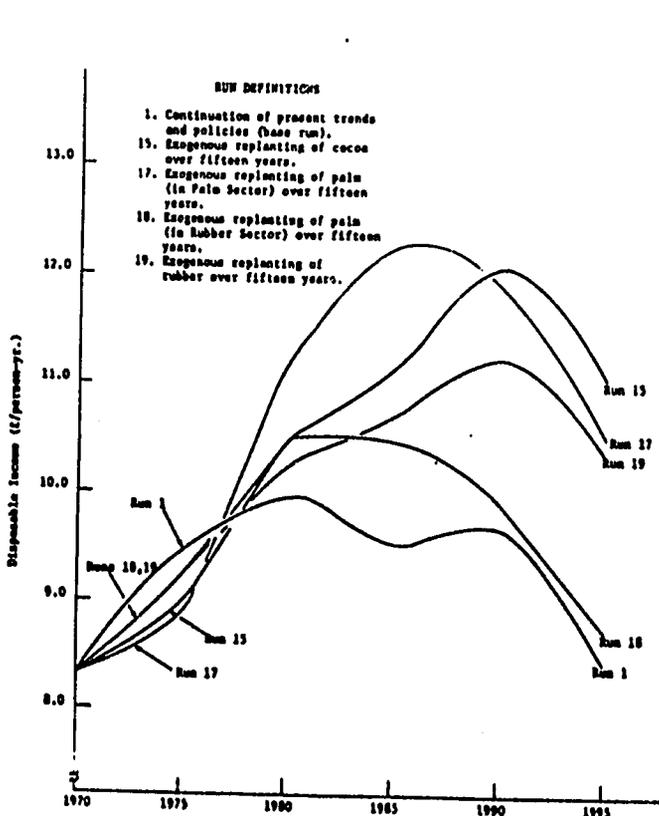
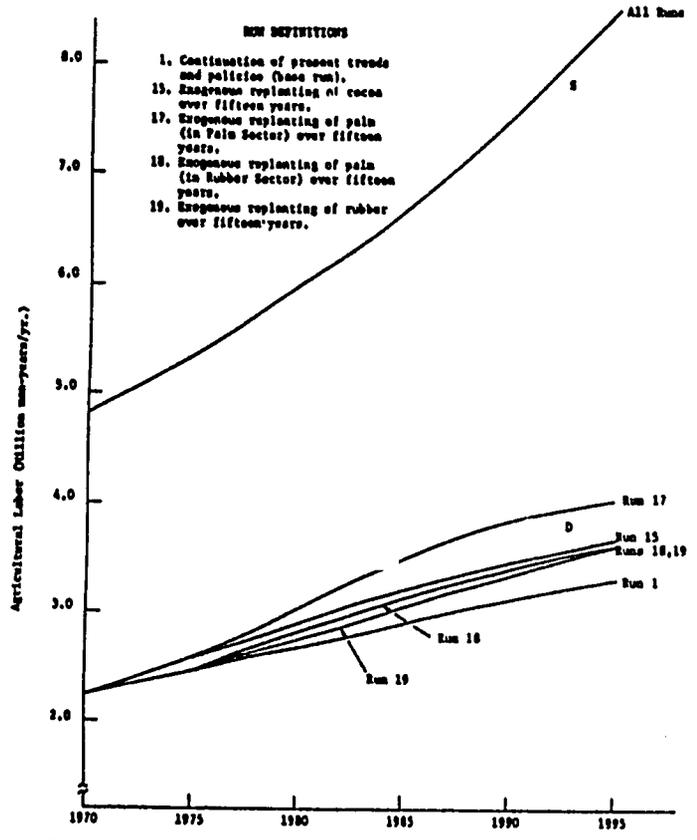
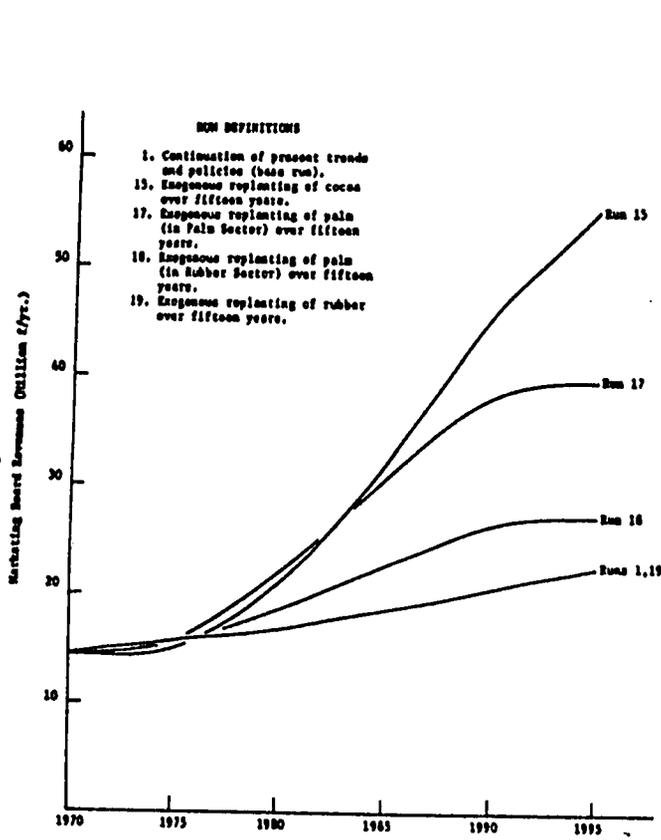


Fig. 28 Foreign exchange from palm oil exports, 1970-1995, under various policy conditions.



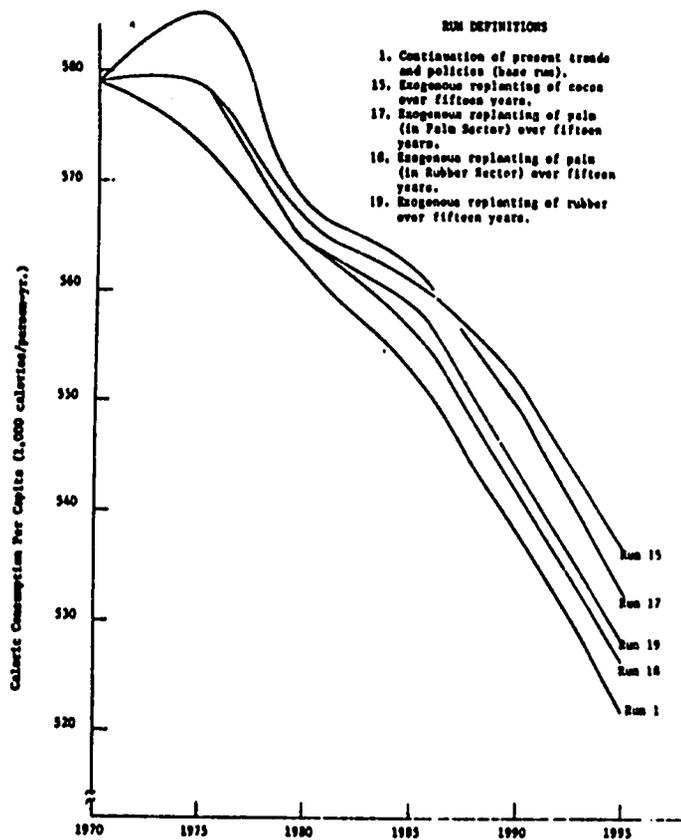


Fig. 33 Caloric consumption (of staples) per capita of the southern monoagricultural population, 1970-1995, under various policy conditions.

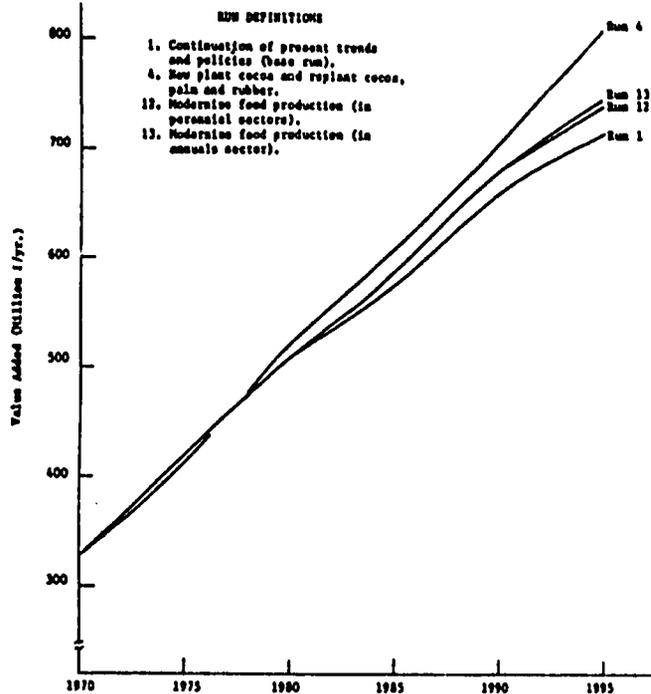


Fig. 34 Total value added in agriculture in the South, 1970-1995, under various policy conditions.

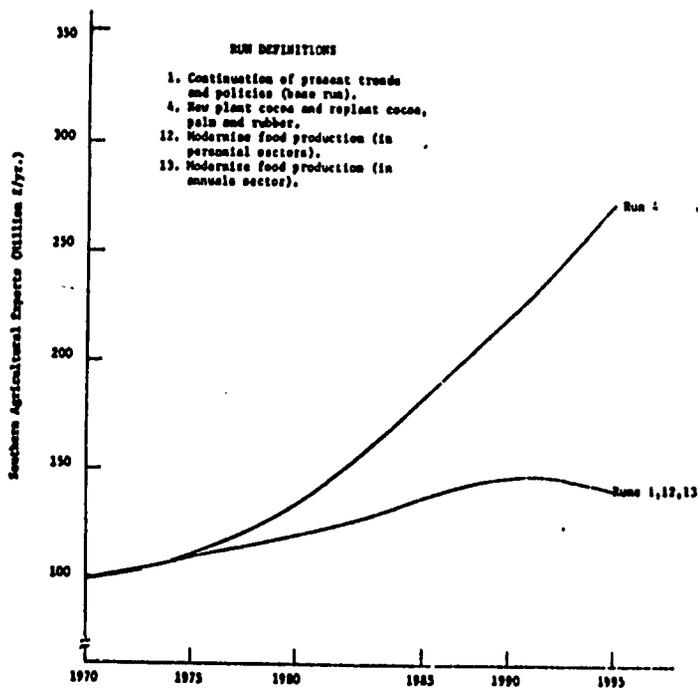


Fig. 35 Foreign exchange from southern agricultural exports, 1970-1995, under various policy conditions.

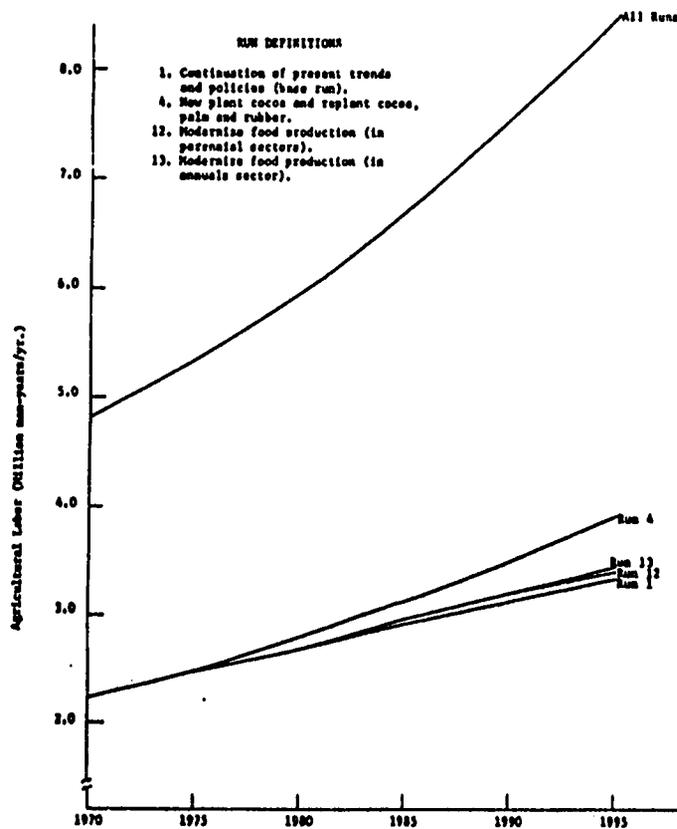


Fig. 36 Southern agricultural labor supply (S) and demand (D) in man-equivalents, 1970-1995, under various policy conditions.

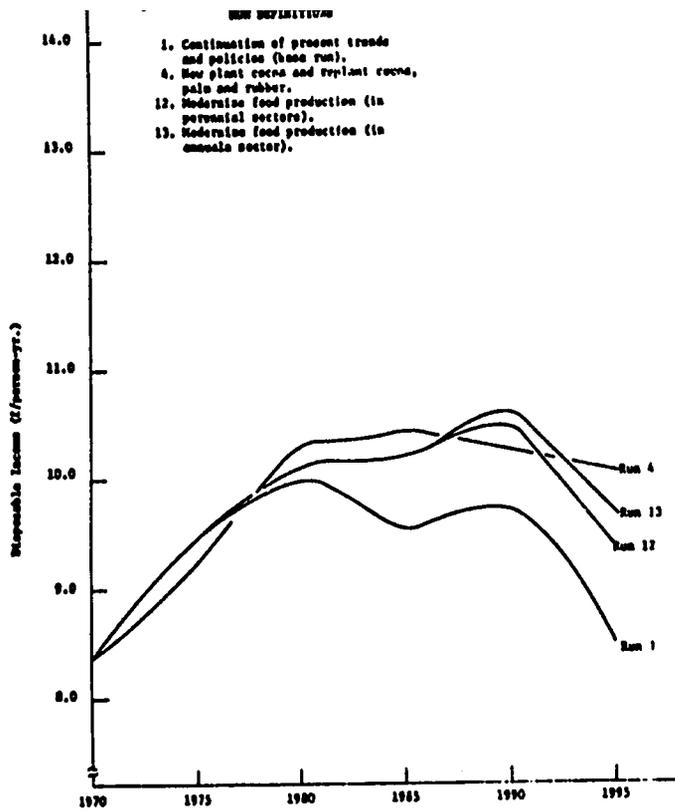


Fig. 37 Disposable income per capita in the South, 1970-1995, under various policy conditions.

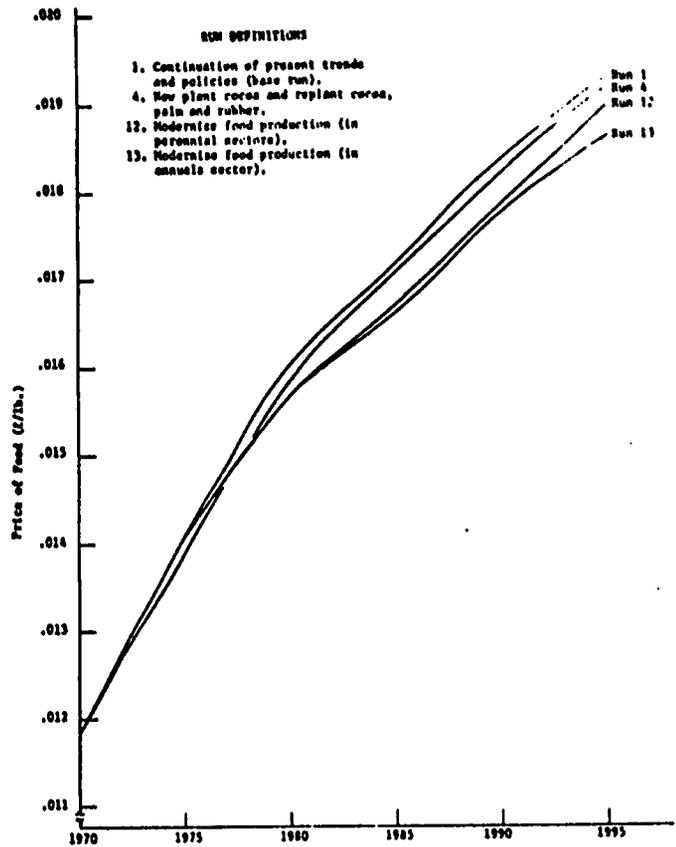


Fig. 38 Market price of food in the South, 1970-1995, under various policy conditions.

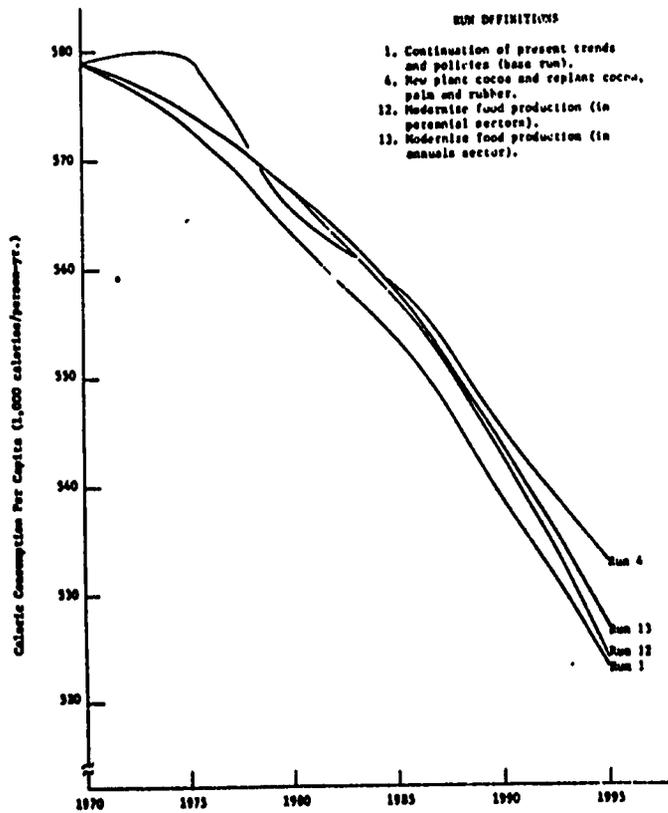


Fig. 39 Calorie consumption (of staples) per capita of the southern nonagricultural population, 1970-1995, under various policy conditions.

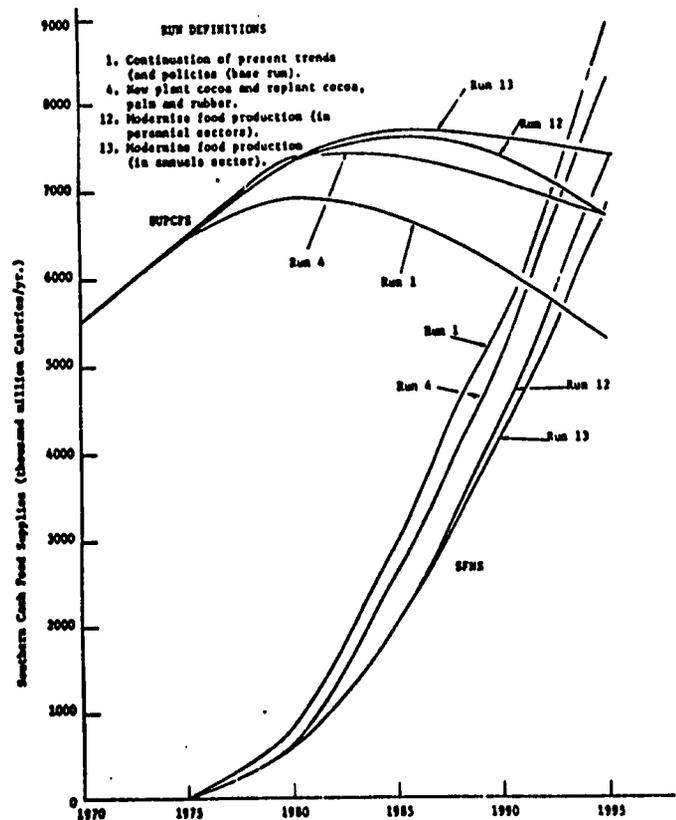


Fig. 40 Supply of staple cash food produced in the South (SUCFPS) and shipments of food from the North to the South (SFFNS), 1970-1995, under various policy conditions.

For aggregate planning to have any meaningful impact in "darting" very close to the "bull's-eye," basic input-output data based on farm management and rural-integrated enterprise research studies have to be mounted as a matter of strict urgency. The nonagricultural sector of the model depended on aggregation of the sectors of an input-output study of Nigeria undertaken in 1959. [11] Studies using these data by Olayide [12, 13] have shown that even though the aggregated input-output coefficients may be considered fairly stable, in developing countries such as Nigeria, the need for a 5-year continuing revision of the data for input-output tables is very urgent. In other words, to have meaningful bases for assessing the structural interdependence and interaction of the agricultural and nonagricultural sectors of the Nigerian economy, we urgently need a new input-output table.

Training of staff capable of using the model for operational planning purposes is also a necessity. In this connection, a sound M.Sc. program in agricultural economics in Nigerian universities (as in University of Ibadan) needs to be given strong governmental and foundation support in the way of funds for basic research designed to work on specific aspects of the simulation model as well as data gathering. In addition, a thorough familiarity with basic systems theory and modelling techniques is essential.

#### VII. Summary.

In this paper, we have presented a case for the need of a quantitative system model of the Nigerian economy as a means of assessing the likely effects of our developmental efforts under economic growth. The output and income-generating/depleting variables in the performance of the Nigerian economy were succinctly examined. The complex simulation model of the Nigerian economy was discussed in diagrammatic terms. Illustrative policy runs were undertaken

to demonstrate some of the advantages and/or usefulness of the model even in its current preliminary and limited form. The results show that different policies run singly or in combination can have far-reaching and intuitively unexpected effects on economic growth. We are much better off to have an idea of the likely effects of our policies on the economy as this knowledge enables us to minimize losses as well as maximize gains under economic growth.

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